

# CURRENT SCIENCE

Vol. XV]

NOVEMBER 1946

[No. 11

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## AGRICULTURAL RESEARCH AND RECONSTRUCTION\*

THE task before us is of vast magnitude and we require the co-operation of every individual in the country for the vast task of construction which awaits us. Our main problem is to link our man-power with the vast material resources of the country and to develop them according to a plan. In planned scientific development lies the salvation of the country and in this great task scientific research workers, particularly those who have chosen agriculture and animal husbandry as fields for their activities, have a great task to perform.

There was a time when India was said to be flowing with milk and honey. Recently we have had to pass in Bengal through a period of famine which took a heavy toll. The immediate task, therefore, before us is to step up food production so that all persons in this country have two square meals a day. The war and famine in Bengal have brought home to us the marginal nature of our food production in a rather tragic manner. Now our task is to rectify this ill-balance between population and food production by producing better

and more food. Research workers in India must concentrate on the task of evolving better and high yielding varieties of crops, in discovering better cultural practices and in placing more efficient tools in the hands of the cultivator. In our search for better tools and means of irrigation we should not forget that those will not be utilised unless they are such as our ordinary cultivator can afford. While concentrating multi-purpose dam irrigation schemes not only to provide irrigation for our thirsty lands but also cheap power for agriculture and industry, we should not neglect to improve the well, the rivulet and the tank and must find ways and means such as cheap and efficient pumps which can be worked with the help of power—human and other animal—which are available and within the competence of the Kisans of India.

Agriculture is the most important industry in the country which gives employment to masses of people and provides food for the entire population. Agriculture and food should have the highest consideration and agricultural research, which places in our hands means of increasing the food supply of the country, should have the highest priority and no amount of attention given to its advancement can be too great. We may remember that agriculture in India is entirely dependent on bullock power and is bound to remain so in the foreseeable

\* Abstract of an Address delivered by Dr. Rajendra Prasad, Hon'ble Member in charge of Food and Agriculture, to the Sixteenth Meeting of the Governing Body of the Imperial Council of Agricultural Research, on 25th September 1946.

future. The cow and her progeny, therefore, claim and should get our attention so that there may be not only a plentiful supply of milk which is such an essential item of balanced diet but also of strong and healthy bullocks necessary for efficient cultivation and other draught purposes.

Since its birth in 1929, the Imperial Council of Agricultural Research has performed great service to the people. Agricultural research in this country has provided high yielding sugarcane, wheats, cottons, and paddies to the cultivator but we must recognise that even in respect of these our production is very much less than what it is in other countries, as the following comparative statement will show.

Average yield per acre (in lbs.)

			Average Yield per Acre (in Lbs.)						
	India	Argentina	U.S.A.	Canada	Italy	Egypt	Japan	Java	Peru
Wheat	636	780	846	972	—	—	—	—	—
Rice	851	—	1333	—	2797	1845	2124	—	—
Cotton	89	151	264	—	—	531	—	—	—
Sugarcane	388	—	—	—	—	—	—	1446	1160
	(in maunds)							(in maunds)	

We have, therefore, no reason to rest on our oars and further and more intensive work which will help the ordinary Kisan to increase the yield is necessary. I recognise, however, that but for the efforts of research workers the shortages in respect of some of these products that we are experiencing now would have been greater still.

The Imperial Council of Agricultural Research provides a meeting ground where Ministers of Agriculture of Provinces and constituent Indian States, representatives of Central Legislature, Indian and European Commerce

and of the Government of India, can discuss problems of agricultural research and guide, co-ordinate and promote research. One of the main functions of the Council is to place at the disposal of research workers throughout India experience of their fellow-workers in this country as well as scientific and technical information derived from foreign countries. The Council also acts as a clearing house of scientific knowledge on the problems of agriculture and animal husbandry. It has provided an organisation for pooling ideas and techniques so that the whole of India may benefit from the experiences of every part. Science cannot flourish in isolation. The best brains of the country must be brought together so that they may be able to exchange views and experience and to pool knowledge. On the Advisory Board of the Council and its Committee the scientific and technical side of agriculture and animal husbandry research in the country is represented, while the Governing Body controls policy and finance. By promoting, guiding and co-ordinating agricultural and veterinary research in India, by training research workers and collecting and disseminating information on research through its publications, the Council has been performing a useful function.

Ultimately, all research must be judged from the contribution it makes to the welfare of the masses. A poor country like India can ill-afford ivory-tower research divorced from the realities of life and the needs of its cultivators. It is the needs of the cultivator which research workers must always keep in view. 'Science in the service of the country' must be our ideal. It is generally admitted that investment in scientific research is the best investment which a nation can make as the returns which it provides are out of all proportion to the money invested. As an example we may cite the case of sugarcane development in this country which has saved the drain of millions of rupees to foreign countries. I can give you the assurance that this Council will have all my support and sympathy.

## NATIONAL RESEARCH LABORATORIES

INDIA'S scheme to set up four more National Laboratories at an estimated capital cost of Rs. 132 lakhs is being launched. The plans for these were approved recently by the Governing Body of the Council of Scientific and Industrial Research.

The Hon'ble Mr. C. H. Bhabha, Member for Works, Mines and Power in the Interim Government, laid the Foundation Stone of the Fuel Research Institute at Digwadih, near Dhanbad, on November 17. The capital cost of the Institute, is estimated at Rs. 14 lakhs.

The Hon'ble Mr. C. Rajagopalachari, Member for Industries and Supplies, and President, Council of Scientific and Industrial Research, laid the Foundation Stone of the National Metallurgical Laboratory at Jamshedpur on November 21. The initial capital expenditure on this laboratory will be about Rs. 43 lakhs.

The Foundation Stone of the National Physical Laboratory will be laid by the Hon'ble Pandit Jawaharlal Nehru, Vice-President, Inter-

im Government, on January 4, 1947, at Delhi, during the Indian Science Congress Session. The estimated cost of this laboratory is about Rs. 40 lakhs.

The Hon'ble Mr. B. G. Kher, Prime Minister, Bombay, will lay the Foundation Stone of the National Chemical Laboratory at Poona sometime towards the end of January 1947. The Government of Bombay recently agreed to the location of this laboratory in Poona and the transference to the Council of the land required for this purpose. The Chemical Laboratory is expected to cost Rs. 35 lakhs.

The first of the five National Laboratories planned for the industrial development of the country was the Central Glass and Ceramic Research Institute costing about Rs. 12 lakhs. The Foundation Stone of this was laid by Sir Ardesir Dalal, former Member for Planning and Development, Government of India, in last December at Calcutta.

## HALF A CENTURY OF RADIO COMMUNICATIONS

(1896-1946)

BY PROF. S. P. CHAKRAVARTI

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## I. INTRODUCTION

ALTHOUGH the period of 65 years from 1830 to 1895 has to its credit a number of fundamental contributions relating to nature, generation and detection of electro-magnetic waves by well-known mathematicians and physicists like Faraday, Kelvin, Clerk Maxwell, Oliver Lodge, Elihu Thomson, Hertz, Fitzgerald, Righi, Branley and Popoff, the year 1896 can only be rightly called the beginning of the age of radio communication.

In 1896, Marconi, a student of Prof. Righi, came to England to conduct his first experiments between the G.P.O. and a site on the Thames Embankment in London, with a view to establish commercial systems. In the same year, he took out his first British Patent relating to wireless telegraph communication which led to the foundation of the present Marconi's Wireless Telegraph Company Ltd. As a result of his experiments, his system was adopted at many places about 1898. The first commercial radio telegraph message was sent on 3rd June 1898 by Lord Kelvin from the Isle of Wight to Bournemouth. In 1899, Marconi made history by transmitting a message over 32 miles across the English Channel.

In Germany, Prof. Braun, working on a system similar to Marconi's, introduced in 1898 a special oscillation circuit, the spark circuit, to which the aerial was connected. The introduction of the Braun circuit known as the "intermediate circuit" separated the functions of generation of H.F. oscillations and radiation. In 1897, another system—"Slaby Arco"—was born in Germany but was later on merged with the other into one under "Telefunken". The weakness in telefunken system was later on overcome by Prof. Wien by his system of "Quenched Spark".

These modest beginnings led to an era of considerable advancement in technique and application relating to every possible branch of radio communication. It is proposed to review the period under two sub-periods 1900-24 and 1925-46.

## II. RADIO COMMUNICATION DURING 1900-1924

(a) *Radio-Telegraph and Telephone Communications.*—The year 1900 saw Marconi's patent for "Syntonic Telegraphy". The range was now increased to over 200 miles. Fleming (later Sir John A. Fleming) who was now associated with Marconi had much to do with the installation of the historic station at Poldhu (Cornwall) for communicating with St. John (Newfoundland). On 12th December 1901 Marconi and his assistant transmitted the letter "S" over 1,600 miles, and in January 1902 sent a message over 3,000 miles from Cape Cod (U.S.A.) to Poldhu (Cornwall). The transmission wave-length was increased to 4,000 metres.

Apart from attaining perfection in rotary gap, synchronous gap and quenched spark systems on the transmitting side, a number of detectors like magnetic detector, electrolytic detector, crystal detector, etc., were invented. Fleming's thermionic diode valve came in November 1904.

About 1904, the position was that Marconi's W. T. Co., Ltd. installed a 150 KW long-wave station at Wales to work with another similar station at New Brunswick, and a second station of this type at Norway to communicate with another one at Marion, Mass. The transmitters were of "Synchronous Gap Type" and the receivers incorporated Fleming's "diodes". In 1907, commercial trans-Atlantic telegraphy on long-wave (employing Marconi's system) was inaugurated between Nova Scotia (Canada) and Clifdon (Ireland). 80 KW long-wave station on Telefunken system at Karlsborg worked with other continental stations.

Poulsen arcs (with modifications by Barkhausen and Pedersen) and rotary alternators due to Goldsmidt, Alexanderson and Fessenden which came between 1902 and 1907 furnished the engineers with sources of continuous waves. With Poulsen arc in hydrogen gas, a frequency of about 1,000 Kc/S should be reached. The arc transmitters were generally made for powers from 30 KW to 3,000 KW for wave-lengths from 600 to 23,000 metres. In 1923 there were 80 stations on the Poulsen Arc system distributed over the whole world, the biggest being Malabar 3,000 KW, and Shanghai and Bordeaux 1,000 KW each. R.C.A. standardised their H.F. alternators for 200 KW and frequencies from 15-22 Kc/S. Telefunken Co. used Alexanderson system with frequency multipliers at Nauen in 1919, and Sweden's first radio-telegraph system with U.S.A. was established with this system in 1924.

In 1907, Lee De Forest invented the three electrode valve (with properties of amplification and oscillation as well as detection) which revolutionised the whole system of radio communications. The "Dynatron Effect" and the invention of screen grid valve by Hull followed in 1915-16. In 1908, Armstrong perfected his regenerative circuit with three-electrode valve, and later on established his method of super-regenerative, heterodyne and super-heterodyne receptions. Experiments were carried on the amplitude modulation of high frequency carrier wave by speech and music by several workers like Round, Fessenden and Hesing. Thus, the foundation for valve transmitters and receivers for telegraphy and telephony was laid.

Marconi station at Carnarvon (Wales) using valves was opened in November 1921 for telegraphic communication between Great Britain and Australia. First trans-Atlantic radio-telephone tests (using long-wave, 60 KW, single side band system) were conducted in October 1915.

(b) *Radio Broadcasting.*—With the end of the World War I in 1918, began the era of Radio Broadcasting. In early 1920, the first broadcasting of musical items in Great Britain took place from Marconi Company's Chelmsford Works. Regular radio broadcasting was made from Marconi stations at Chelmsford and Marconi House (London) in 1921 and 1922 respectively before the establishment of B.B.C. in the later part of 1922. Broadcasting was

born in the United States in November 1920. On that day, station Kdkk in East Pittsburg inaugurated the first broadcasting service in U.S.A. In France, regular broadcasting was begun from 1921 from a military station in Eiffel Tower, and in the following two years it started in other European countries.

(c) *Radio Direction-Finding*.—The directional properties of open and loop aerials were studied by Braun, Weagant, Marconi, Pickard, Bellini and Tosi in the opening years of the present century. Radio methods began to be employed for direction-finding during the period under review. Use of rotating frame aerial was made by Braun, whereas Bellini-Tosi developed their radio-goniometer. Adcock modification of the Bellini-Tosi system made during the World War I was applied to the commercial field a few years later. Marconi-Bellini-Tosi compass, Telefunken wireless compass, U.S. Navy radio compass, etc., were evolved during this period. Robinson's method of direction-finding was patented in 1918. Ideas on the use of radio beacons were fast dawning.

(d) *Marine Radio Communication*.—About 1899 big Atlantic passenger liners began to install in them radio-telegraphic stations mostly of Marconi's make. On account of its having the fixed radio stations on the European and American Coasts, the Marconi Company was even at this early stage at an advantageous position with regard to ships' radio traffic. Some passenger vessels were also fitted up with radio system of the Telefunken type and a few of them with that of R.C.A. type. By 1909 most of the important passenger vessels had been equipped with wireless apparatus majority of them being of Marconi make. The first conference solely relating to marine radio communication was held at Berlin in 1903. Subsequently, this subject received due attention at subsequent international radio conferences held in Berlin and London in 1906 and 1912 respectively. The total number of coastal and ship stations was 3,280 and 9,050 in 1913 and 1920 respectively.

(e) *Radio Transmission of Pictures*.—Even the radio transmission of picture was carried out during the period under review. In November 1924, the Marconi Company in collaboration with the R.C.A. successfully transmitted photographs of the Prince of Wales, President Coolidge and Mr. Charles Hughes by radio, which were reproduced in *New York Times* and *Daily Telegraph* of 16th December 1924.

(f) *State of Knowledge of Radio-Wave Propagation*.—A modification of Hertz's formula was evolved for short distance propagation over flat earth of finite conductivity. For long distances, attempts were made by mathematicians and physicists to deduce formulæ for field strength by taking into account the curvature of the earth's surface, but formulæ so obtained were found inadequate to explain the observed values. In 1902, Kennelly and Heaviside simultaneously suggested that upper atmosphere rendered conducting by sunlight might cause such deflection and force the waves to follow the curvature of the earth. Therefore the wave propagation in the space between two concentric conducting spheres was considered but the results again failed to agree with the measurements. The best theoretical-

cum-empirical formula of the period was the Austin-Cohen formula.

The above review of radio developments during 1900-24 will show that the Spark and Arc type transmitters were replaced by valve transmitters and the wave-responding devices like coherer, magnetic, electrolytic and crystal detectors by valve receivers. It will also be noted that radio-telegraphy and telephony, broadcasting, telephotography, direction-finding and marine communication were in commercial operation during this period. The allocation of wave-band agreed upon about 1920 was as follows:—20,000-3,000 metres for trans-continental telegraph and telephone communication, and 3,000-200 metres for broadcasting and marine communications.

With the end of the World War I and growth of radio broadcasting, a large number of amateur experimenters were not satisfied with merely listening to the broadcast programmes but wanted to work experimental transmitters of their own. They were allocated the wave-band below 200 metres which was then considered useless for serious work. The amateurs used low power and increased the range of their transmission more and more by making the wave-length less and less. Very soon astounding reports of two-way communication between lands separated by wide seas as well as observations for associated phenomena like fading, etc., appeared in papers. Marconi and Franklin made thorough investigation on the propagation of radio signals on wave-lengths below 100 metres. His experiments from Poldhu on 97 metres with parabolic reflector aerial and receiving point on his yacht 'Elettra' could give satisfactory results over considerable distances. He began trials during 1916-19 with wave-lengths from 2 to 15 metres and demonstrated the quasi-optical character of ultra-short waves.

### III. RADIO COMMUNICATION DURING 1925-46

(a) *Radio Telegraph and Telephone Links*.—About 1924, the British Post Office had been planning a long-wave telegraph system with Canada, Australia, India and South Africa. Marconi then took up the boldest step of his life and succeeded in inducing the B.P.O. to give up their plans for long-wave network and accept a new system using short-waves between 10 and 35 metres on the beam principle. Marconi's own experience with directed short-wave beam and his extraordinary intuition gave him courage to sign the contract. The work of construction that followed involved a multitude of problems in respect of transmitters, receivers and aerials, all of which were solved with success. On 25th October 1926, the Canadian beam was opened and other connections came into being the following year. The success with the short-wave was so complete that the competing telegraph cable companies lost a great deal of their traffic resulting in a "merger company" in 1928. In addition, short-wave telephone links connecting Britain with other countries were opened in 1928 and following years. The path shown by Marconi and British Post Office was quickly followed by U.S.A., Germany, France, Spain, Russia, Japan, South America, etc. Table I roughly shows the number of intercontinental radio-telephone circuits of the world, existing and proposed on January



1, 1932. The longest of the circuits is between (London) Britain and (Sydney) Australia, having 17,000 Km. distance.

TABLE I

No.	Countries or continents in or between which circuit exists	No. Existing	No. Proposed
1	North America—Britain	4	2
2	North America—Europe	—	1
3	North America—South America	2	3
4	Britain—South America	3	—
5	Europe—South America	11	2
6	Europe—Africa	2	10
7	Britain—Asia	—	4
8	Britain—Australia	1	—
9	Europe—Asia	5	1
10	North America—Asia and —Australia	1	3
11	North America	1	5
12	South America	3	1
13	Asia—Australia	4	1

In addition to the above, there has been further extension of radio-telephone circuits till the outbreak of World War II. Among them may be mentioned the Paris-Moscow, South America-Japan, Europe-Japan, Europe-South America, Europe-Near-East, U.S.A.-Switzerland, and U.S.A.-France telephone links which were opened immediately before the war.

The valve transmitter equipment upto 1924 or so generally consisted of self-oscillator (of large power at the transmitting frequency) and modulator system. Subsequent to 1924, it was changed to a master oscillator (either tuning fork or crystal controlled, or Franklin master oscillator) followed by separator, frequency multipliers and radio frequency power amplifiers (or driven circuits), and the modulation was applied either at low-power or at high-power r.f.-driven stage. Transmitters delivering upto 60 KW to aerial at these wave-lengths were developed. Transmission of carrier and both side bands was employed in earlier short-wave telephone links, but in later ones only "single side band" was transmitted. The valve receiving equipment was of super-heterodyne and double super-heterodyne types for telephone and telegraph systems respectively. Commercial telephone links were fitted up with "Voice-Operated Differential Anti-Singing Device" and "Privacy or Secrecy Device". Considerable studies and development took place in this connection on antenna arrays (including Sterba, Marconi, T.W. and horizontal arrays) and rhombic antennas during 1926-35. For high voltage power supply to the final and penultimate stages of transmitting system, increasing use of grid-controlled mercury arc rectifiers of steel tank and glass bulbs types was made during this period.

Experiments on "multi-channel working" (simultaneous telephone and telegraph) were carried out on the Madrid-Buenos Aires short-wave radio link, and they proved successful as by use of inverters and spreaders in the telephone channel and by appropriate allocation of frequencies telegraphy at 125 words per minute was possible at the same time as speech.

Multi-channel operation was then applied to a few other links. Multi-channel operation (giving 9 telephone channels simultaneously) was adopted with great success on "ultra-short-wave radio-telephone links" installed to work with the trunk telephone networks of the various countries. The year 1937 marks the introduction for the first time of a multi-channel unattended remote-controlled radio link in the regular long-distance telephone network.

Transmission of pictures over radio links in U.S.A., Japan and on the Continent of Europe as well as over some of trans-continental links was carried out with success. An equipment like Acme Facsimile equipment (modified for radio circuits by Marconi Co.) was used at the terminals for the purpose.

To get over the difficulty due to severe attenuation on short-wave trans-continental links at the adverse periods of the sun-spot cycle, erection of high gain directional aerials was taken up. An array of rhombic antenna (known as multiple unit steerable antenna) was designed for the receiving stations to obtain an additional gain of 12 to 15 db in signal to noise ratio for 40 to 50 per cent. of time during sun-spot periods in order to maintain the circuits at a commercial level.

(b) *Marine Radio*.—During this period, practically all ocean-going vessels were equipped with transmitters and receivers as well as direction-finding equipments. The most substantial advance in mobile services made during this period was "Ship-to-Shore Telephony". The wave-lengths used varied from 90 metres or so to about 18 metres depending upon the distance over which communication was carried on. Ship-Shore and Shore-Ship telephone services were first opened in 1929 between S.S. "Leviathan" and the United States and between S.S. "Majestic" and England. In 1930, they were extended to include S.S. "Majestic" and the United States, S.S. "Leviathan" and Europe, and S.S. "Olympic" and S.S. "Homer" with countries on both sides of the Atlantic. These services were made possible with co-operation of the B.P.O., the American T. & T. Co., and International T. & T. Corporation.

Mackay Radio & Telegraph Co. opened a number of ship-to-shore telegraph stations on the Atlantic Coast of U.S.A. In 1932 this Company operated radio service of 215 American merchant vessels. The International Marine Radio Company operated the wireless services of the trans-Atlantic fleet of the Cunard Steamship Company as well as of 160 ships installed with radio apparatus of various types. Several types of transmitters and receivers were developed for use on ships, as well as in coastal stations by International T. & T. Corporation, Federal Telegraph Co., and International Marine Radio Co.

About 1939, International Marine Radio Co. Ltd., introduced the first commercial telegraph transmitter providing high quality service on all marine telegraph frequency bands. Design features of the new transmitter include variable tuning, master-oscillator control over the whole frequency range (16.9-55, 583-820, and 1875-2,800 metres) with optional crystal control on a number of spot frequencies. Another interesting development about the same time

was that of a 135-watt marine radio beacon equipment satisfying the widely varying requirements of a number of countries.

(c) *Aviation Radio*.—This relates to radio transmitters, receivers, altimeters, direction-finding (guiding) and landing instruments on the aircraft as well as radio transmitters, receivers, direction-finding and landing equipment at ground stations. Aviation at an early stage made use of radio direction-finding both in the aircraft and on the ground. For night flying, the direction-finding system employing Adcock modification was used from 1926. About 1930, the European countries came to agreement for a common triangle network of radio beacons for the benefit of aviation. The problem of "blind landing" was solved in principle about 1930, and the solution was taken up for development by C. Lorenz, A.G., Berlin.

Even about 1935 practice in Europe regarding aviation radio equipment was not standardized to anything like the extent to which it had been in U.S.A. and there was no agreement till then as to the most advantageous type of radio equipment for aerial navigation. Experimental equipment like "several types of homing beacon", "ultra-violet-wave blind-landing gear of the Lorenz pattern", "automatic direction-finders for use in aircraft", etc., was on trial. In 1936, the Lorenz system was adopted in Europe, Far-East, Australia, South America and South Africa, and in 1937 there were 35 air port and 200 aircraft installed with this equipment. In the following year, "Z" and "Fan" maker beacons using frequencies of the order of 75 MC/S were introduced along routes in U.S.A.; the Australian authorities accepted a plan for using U.S.W. frequencies for range navigation and blind approach beacons, and Lorenz blind approach system was installed and demonstrated at Indianapolis, U.S.A. In 1938-39, the Lorenz system with certain modifications as to wavelength, etc., was adopted all over the U.S.A.

Unlike the Europeans, the Americans directed radio beacons between the airports. During the World War II, through co-ordination of European and American air radio systems at the world conferences in Chicago in 1944 and Montreal in 1945, new aids for long-distance aerial navigation such as "echo-radio collision averters" and "Loran system" had been added. Further research on the landing system—a system for glide path indicators—working on 45 cms and employing an equi-modulation path was taken up in U.S.A. New models of Standard-Busignies "Automatic Radio Compass" with the extension of the frequency range to include band 150-1,500 KC/S had been produced to enable the pilot to take bearings on broadcast stations. A small hand-operated loop direction-finder, combined with a "homing course indicator", was also developed by S.T.C. Ltd., London.

About 1936-37, for communication purpose the tendency was to use transmitters of higher and higher power both on medium and short-wave bands. The K.L.M. in 1937 introduced 200-watt equipment for medium and short-wave telegraphy on their routes to Batavia. Standard Telephones & Cables Ltd., London, completed in 1937 the development of a radio-telephone equipment with remote control system for fighter aircraft. The expansion of civil aviation and hence the need for radio channels

for communication purposes resulted in wider adoption of crystal control for transmitters. Transmitters for civil aircraft were equipped with upto 10 crystal-controlled spot frequencies. The demand for radio communication for private aircraft led to allocation of wave-lengths in the ultra short-wave band. About 1932-33, a micro-ray communication system operating on 15 cm wave-length was installed for the British Air Ministry to work between Lympe and St. Inglevert aerodromes. It was to be used for announcing the arrival and departures of planes and for routine service messages. It was the first commercial application of the micro-ray communication system.

(d) *Radio Direction-Finding*.—Most of the direction-finding equipment developed during this period were covered under 'Marine Radio' and 'Aviation Radio'; and, therefore, this section would now be dealt with in brief.

*Direction-finding by reception method*.—Loop direction-finder was followed by Marconi-Bellini-Tosi system of direction and sense-finding and subsequently by Marconi-Adcock system for operation on medium and short-waves. Other developments during the period were the cathode-ray direction-finder, spaced-loop direction-finder, pulse direction-finder system and compensated loop direction-finder. In addition, "Homing Device" and "Automatic Radio Compass" were invented and proved valuable.

*Direction-Finding by transmission method*.—Radio beacons developed at the beginning of this period were considerably improved and new types as discussed in previous sections were evolved.

Other radio aids to aerial navigation were—

(1) Radio Range on long and U.H.F.-waves, (2) Makers of various types to increase usefulness of (1), (3) Altimeters and (4) Instrument Landing Systems.

(e) *Radio Broadcasting*.—Radio Broadcasting which originated about 1920 in Europe and America had phenomenal growth in many countries during its short career of about 25 years. Its importance from view-point of (1) education, (2) spread of information and culture, (3) entertainment, (4) publicity and (5) propaganda, was fully realised everywhere. It was recognized as a powerful tool in the hands of the State both during peace and war. In Great Britain and most European countries, Canada, Australia and Japan, the organization of broadcasting was a national monopoly in the sole interest of the nation. In the U.S.A. it was in the hands of private enterprise. In India and some other European and Asiatic countries it was controlled by the Government.

The medium-wave band 200-545 metres was used for broadcasting. In addition, a portion of the long-wave band 1,000-2,000 metres was allocated for broadcasting in temperate countries and short-waves were allowed for broadcasting in tropical and semi-tropical countries as well as for "Overseas" broadcasting. The C.C.I.R. Conferences at Madrid and Cairo were most important so far as allocation of channels was concerned. In temperate countries the "regional" and "national" broadcasting was on medium and long-waves respectively. In tropical and semi-tropical countries the "regional" and "national"

broadcasting was on medium and short-waves respectively. For Overseas broadcasting, short-waves were used on the beam principle. The total number of medium-wave stations in the whole world in 1939-40 was about 2,200, with the antenna power in watts per sq. kilometre about 0.1. A large number of short-wave stations were installed in India, China, Iran, East Indies, Near-East, South American countries, etc. Overseas broadcasting on short-waves was carried out from England, France, Germany, Russia, Japan, India and North America.

From 1925 to 1934, modulation at low-power level was generally in great favour with broadcast transmitters. Since 1935, with increase in power of the transmitters, high efficiency modulation systems had been holding the field. "High power class B system" was employed widely all over the world. "Doherty System" was applied to some transmitters in America, while "Chireix System" was in use here and there on the Continent of Europe. Series modulation at penultimate or final stage, invented by Ditcham of Marconi Co., was applied to several Marconi transmitters (i.e., installed at Droitwich, Motala, Delhi, etc., about 1935).

The extent to which this trend toward high power had already made itself felt was shown by the fact that about one in seven of 250 existing medium and long-wave stations in 1937 in Europe and North Africa were rated at 100 KW or over, and about one in four at 50 KW or over, while 55 per cent. had a rating of not less than 10 KW. Two 150 KW M.W. transmitters were installed in Japan about 1937. In U.S.A., where broadcasting did not receive financial support from the Government sources, the use of high power stations was not so widespread but transmitters with outputs of 50 KW were not uncommon and manufacturers had in hand about 1938 designs for medium-wave transmitters upto 500 KW. This trend towards high power was also shown during 1938-45 in short-wave transmitters which were built for ratings as high as 100 KW. "Inverted radio frequency amplifiers" originally developed for television transmitters, were used in B.B.C. Empire station 50 KW short-wave transmitter and in Rome station 10 KW S.W. transmitters about 1939. The grid-controlled H.V. mercury arc rectifiers of steel tank type found increasing use in transmitters. The Marconi Co. developed a power-saving arrangement, called "the floating carrier system" which was incorporated in many transmitters. Mast radiation of series and shunt excitation types developed for medium-wave broadcasting to prevent the sky (high angle) ray from interfering in the service area became quite popular. Reception of short-wave signals by "space and frequency diversity methods" and re-radiation of programmes on medium-waves became fully established in many countries.

A tuning fork control system for "common wave-length broadcasting" was installed to control the wave-lengths of Frankfurt-on-Main, Trier, Kassel and Freiburg stations. Several more networks of the type were introduced in other European countries. Two or more broadcast transmitters occasionally modulated with identical programme were operated with their carriers synchronised.

After the Cairo Conference (1938), broadcasting wave-lengths were discussed at Montreux (1939) and a new plan for the European Zone was evolved. Much attention was given to the use of the synchronising systems, anti-sky wave and directive aerials to utilize the limited number of channels available to the best advantage. The plan for 1940 included an extensive use of these methods with an increasing number of high power stations and involved 61 groups of synchronized networks and 48 cases of directive aerials for the European Zone.

Prof. Easu of Germany was perhaps the first to test the usefulness of wave-lengths below 10 metres for broadcasting in cities during 1929-30. Experiments with ultra short-wave A.M. system for local broadcasting on 7.85 m were also carried out in Holland during 1930-31, and its advantages realised. Ultra short-wave F.M. (Frequency Modulation) broadcasting on frequencies 42-50 MC/S became very popular in U.S.A. and a large number of F.M. stations on Armstrong and Crosby systems had been installed. Experiments were also carried out on 84-112 MC/S and 100-165 MC/S bands. Pulse Time Modulation system, invented in U.S.A. during 1945, was capable of transmitting a large number of broadcast programmes simultaneously with a carrier frequency of the order of 3,000 MC/S.

The straight and reaction types of broadcast receiving set for long and medium-wave bands evolved in the beginning of this period were replaced by modern superheterodyne broadcast receivers for operation on long, medium and short-wave bands. The modern receivers incorporated many features like automatic volume and frequency controls, tuning indicators, push-button tuning, band spread, stabilisation of frequency calibration, negative feed-back, etc. Considerable attention was given to the development of F.M. broadcast receivers. It was now possible to have a broadcast receiver for F.M. signals on 42-50 MC/S and A.M. signals on short and broadcast wave-bands. Further studies were made on super-regenerative receivers in U.S.A. and Japan for ultra-short-wave reception.

(f) *Television*.—The possibility of seeing events at places remote from the observer was a dream of humanity for many centuries. The technical advances during the period under review made this dream an accomplished fact.

A number of workers made their contributions to this field, among them may be mentioned Campbell Swinton, Kerr, Baird, Zworykin, Dieckmann, etc. The "high definition television" was accomplished by 1935-36. Modern method of scanning by electron beam (using inter-laced scanning) was evolved. Emithron Television and Baird Electron Cameras were developed. Outdoor broadcasts had started in several countries since 1937. Special type of U.S.W. transmitter to handle this large band was developed. The Marconi-EMI high definition system as used at the Alexandra Palace, London, transmitted 50 picture elements per second each of 405 total lines. Over half a dozen cameras were used. The feeble signal from the camera after amplification in an unit built into the camera itself was passed with

synchronising impulses through six stages of amplifiers designed to give linear amplification over 4 MC/S range. Two final stages in modulation amplifier employed high power water-cooled valves which were arranged to modulate the final stage of radio frequency transmitters. R.F. circuits of the vision transmitter at Alexandra Palace consisted of a Franklin temperature-compensated M.O. followed by a doubler and five stages of r.f. power amplification at 45 MC/S, peak output of the transmitter being 17 KW. About 1937, Thomson-Houston high definition system installed by French P.O. in Paris gave 50 picture elements per second each of 455 lines and the vision transmitter gave 30 KW peak power on 46 MC/S. There was an advancement in the "intermediate film pick-up" in Germany. By means of a mechanical scanner, electron multipliers and a special process, a film scanner was produced which photographed, developed and transmitted the picture within 16 seconds of the action. About 1939, National Broadcasting Company made a start with experimental television broadcasts using a transmitting antenna on the top of the Empire State Building in New York. From 1938 for the outside broadcasts two mobile units equipped with transmitters and receivers were used in London and the signals from them were received at Highgate whence they were conveyed to the Alexandra Palace at vision frequency on the television cable.

Experiments on two-way television transmission were carried out in U.S.A., Great Britain and on the Continent on the co-axial cables. With the invention of the Pulse Time Modulation system, it would be possible to work both one-way and two-way televisions on micro-wave carrier over very great distances by use of "radio repeaters" installed at short intervals.

A large number of manufacturers in U.S.A., Great Britain and on the Continent put in the markets during 1938-40 television receiver sets, prices ranged from about £40 to 100 per set which were not high considering circuit involved. They consisted of two or more stages of carrier frequency amplification, frequency changer, five or more stages of I.F. vision amplifier coupled together by band-pass filters and a second detector of special low impedance diode valve. The output of the detector contained the picture signals and the synchronising impulses, and the picture signals were made to control the intensity of the light spot on cathode-ray tube in the set. The scanning sequence was accomplished by two sets of deflecting plates connected to linear generators and the synchronising impulses locked the scanning circuits of the receiver with those of the transmitter.

(g) *Radar and Associated Systems.*—The most phenomenal achievement of the World War II (1939-45) was the Radar. The fundamental principle of Radar—the location of a distant object by obtaining its range, bearing and elevation (with respect to the observer) with the help of the reflected impulse-modulated radio-wave and its basic technique were no doubt simple, but around this phenomenon had grown up so many complex applications varying widely in function and technique that they constituted a new specialised branch of

radio and electronic engineering. As during the war period, most of the work on Radar was done through British-American collaboration, only the developments in one country, namely, Great Britain, need be reviewed here. Dr. Sir Watson-Watt was the central figure associated with this work. It was known as early as autumn of 1935 that range, bearing and angle of elevation could be measured by radio-waves of wave-length about 10 metres for an aircraft by a single combined transmitting and receiving station. The radio-location station measured in 1935 range to 1 Km and bearing to  $1\frac{1}{2}$  degrees at 60 Kms. Angle of elevation to  $\frac{1}{4}$  degree could be measured in 1937. Towards the end of 1935, the "Home Chain Stations" on wave-lengths 10 to 12 metres were opened on the eastern coast of England. In 1938-39, Bute-ment in England experimenting on radio-location station on 1.5 metres for ship location recognized this as solution of the problem of detection of low-flying aircraft. Another home chain of stations on 1.5 metres was opened soon after.

In 1940, several concerns, in co-operation with the Research Establishments of the Air Ministry and Department of Supply as well as the various universities (specially Birmingham University), were called upon to carry through a research programme leading to the development, design and construction of the "Centimeter Radar" for anti-aircraft fire control, searchlight work, and use on aircraft and ship. In 1941, one company developed a 50 KW, 10 cm equipment known as GL3 for A.-A. fire control. Experiments were started in 1941 at M.O.S. Research Establishment on the automatic following of aircraft by Radar Equipment, leading to development of "Glaxo". In 1944, with V-1 threat on London, the development and manufacture of a small Radar Unit working in 10-cm band known as "Cupid" (transmitter-receiver in which being mounted above the predictor) were carried through successfully. Many types of air-borne equipment like H 2S system—an extension of P.P.I. (Plan Position Indicator) system—were designed and manufactured.

The heart of the centimetric Radar—the "high power magnetron" working on the cavity resonance principle—was developed on the basis of work by research groups at Birmingham University and General Electric Co. These magnetrons could be built to generate up to 2,500 KW on 10 cm wave-length and 100 KW on 3 cm wave-length. Mercury vapour thyristors were developed for Radar modulator work. Stable crystal valves to be used as first detector or converter, Klystrons (invented by Varian Brothers in U.S.A.), dielectric guides, etc., were all extensively studied and developed during 1940-45.

The years 1940-45 also saw development in "Servo-mechanisms" for accurate remote position control for searchlights, guns and Radar aerial system. For insulation of centimetre wave aerials and other components, the well-known low-loss material—"polythene"—was invented and widely used.

Several other navigational systems based on Radar or pulse transmission technique, namely,



Radar Beacons, Beacon Navigation systems, ("Obce", "Gee-H", "Shoran", and "micro-H" systems), Gee and Loran, were developed. Radar proved not only to be a powerful weapon during the war period but would continue to do so during the peace-time in various fields.

In addition, Radar would prove to be a powerful instrument in the hands of research workers. Investigations which could not be taken up up-to-date would now be carried out easily. A few months ago, as a result of U.S. Army radar experiments during which radio-waves were recorded to have reflected back from the Moon (situated about 238,000 miles from the Earth), it was thought that topographical mapping of the planets, determination of their composition, communication with them and rocket trips to them would be taken up in near future. Almost simultaneously the Australian Radio physicists associated with the Council of Scientific and Industrial Research of that country, announced their having established Radar contact with the Sun.

(h) *State of Knowledge of Radio-Wave Propagation.*—In 1925, Appleton and Barnett as well as Smithrose and Barfield in England, and Breit and Tuve in U.S.A., gave an experimental proof of the existence of an atmospheric ionized layer from 90 to 125 km above the earth (as obtained in temperate countries) called "Kennelly-Heaviside Layer" (main E or E<sub>1</sub> region). Later on in 1927, Appleton discovered an upper ionized region from 240 to 350 Kms above the earth called "Appleton Layer" (main F or F<sub>2</sub> region). The "magnetospheric theory" given by Appleton and Hartree was experimentally corroborated. Considerable amount of valuable work was done in most of the countries on the equivalent height, maximum equivalent ionic density, ionic gradient, collision frequency, nature of charged

particles and ionising agency relating to the different layers. The nature of propagation of long, medium, short and ultra-short and micro-waves was fully investigated. The existence of an ionized layer between "E" and "Ozone layers"—"D Layer"—specially during the day-light hours, was discovered in 1928 by Appleton. Experiments during this period also indicated existence of ionized regions in troposphere and lower stratosphere, called "C layers". The effect of 11-year sunspot cycle on the propagation of short and longer waves was studied. Valuable contributions were made during the period on (1) Reflection of radio-waves from the ground, (2) field strength measurements, (3) fading and fading control, (4) polarization of signals and (5) atmospherics (including their wave-forms, their direction of arrival, their number/minute and their intensity on various wave-lengths).

#### IV. Conclusion

No science or technology has ever made such a phenomenal advancement within half a century as this Radio. Even its different branches have become vastly specialised subjects. From its modest beginnings in laboratory, it got firmly transplanted into the life of man. Radio is now indispensable to the nation both during peace and war. It is hoped that in future full-fledged Institutes (to be called Radio Institutes) solely devoted to advanced instruction, research and development in different branches of Radio will be established instead of allotting a single Department to this very important subject in a science or engineering institute.

*Note.*—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India.—Ed.

### ENGINEERING RESEARCH IN HYDERABAD STATE

**A**N outstanding event marking a new era in the history of engineering progress in Hyderabad was the gracious *Firman-e-Mubarak* of His Exalted Highness the Nizam giving his Royal assent to the establishment of an Engineering Research Department in the State.

In inaugurating the new Department, the Nawab Sahib of Chattari, the then President of H.E.H. the Nizam's Executive Council, declared:—

"... India is a poor country and any conception, however beautiful and good it may be, is of no value if it is beyond the financial means of the country and, therefore, it is for the engineers to find out how to make things cheaper, so that we may be able to give the benefit of good houses, bridges, communications, etc., to the poor. Your Research Department will be, I hope, one of the blessings of the Osmania regime, which will remain in the history of Deccan as one of the brightest periods for progress and improvements."

The full scheme of the Engineering Research Laboratories is contemplated to be worked out in such a way that the whole plan may be progressively developed in yearly stages as a

Five-Year Plan. For the preparation and the execution of this plan, the Government has appointed Dr. S. P. Raju as the Director. He will in addition to this be responsible for initiating, organizing, co-ordinating and directing engineering research in the Hyderabad State. The scope of the Department will include problems connected with all branches of engineering like (1) Irrigation, (2) Soil Mechanics, (3) Building Materials, (4) Building and Housing Research, (5) Roads, (6) Public Health Engineering and (7) Hydraulic Machinery.

After careful consideration it has been decided to locate the permanent laboratories below Himayatsagar which is one of the two reservoirs constructed as a flood preventive measure after the disastrous flood of 1908. The site extending over an area of about 500 acres of land is at the commencement of the Irsalgandi Channel which carries the supply of drinking water to the southern portion of Hyderabad City. The site ensures an adequate and continuous supply of water for large-scale hydraulic experiments and provides a quiet and congenial atmosphere for research with sufficient scope for future expansion.

To make the station a self-contained unit, it is planned to construct not only laboratories, library, etc., but also quarters for the staff with all civic and social amenities and a guest house for visitors.

At the suggestion of the Director, it has been decided that while arrangements are in progress for the development of the Himayatsagar site, research work may be undertaken in temporary sheds erected in the grounds of the Red Hills Water Reservoir. Various problems received from the different branches of the P.W.D. and the Local Fund Department are already under investigation in the different laboratories.

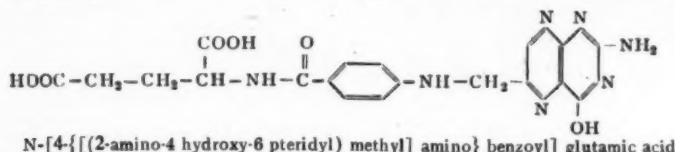
The initial plan includes:—

- (1) Expenditure of Rs. 3½ lacs for the acquisition of 500 acres of land under Himayatsagar and the partial development of permanent laboratories and staff quarters;
- (2) Expenditure of about Rs. 3,20,000 for sheds, equipment, etc., for starting research work in temporary laboratories;
- (3) Establishment of a field research station in Nizamabad, for investigation of engineering problems connected with Nizamsagar development at a cost of Rs. 67,000; and
- (4) Reservation of Rs. 20,000 for the training of research personnel.

## SYNTHESIS OF FOLIC ACID

LAST year Angier *et al.*<sup>1</sup> announced the synthesis of a compound showing physical and biological properties identical with those of the *L. Casei* factor (folic acid) isolated from the liver. The synthetic product, when administered orally or parenterally in daily doses of 5-15 mg., proved effective in sprue,<sup>2</sup> Addisonian pernicious anaemia,<sup>3</sup> macrocytic anaemia of pellagra, sprue, pregnancy or of nutritional origin,<sup>4</sup> megaloblastic anaemia of infancy<sup>5</sup> and chronic diarrhoea.<sup>6</sup>

In view of the dramatic results reported on the hæmopoietic activity of folic acid, further details of the chemical constitution and synthesis of folic acid were anxiously awaited. A recent communication by the same group of 16 authors<sup>7</sup> hailing from the Lederle Laboratories and Calco division of the American Cyanamid Company discloses particulars of the degradation reactions used to characterise the liver *L. Casei* factor, based on which the following structure was postulated:—



Proof of the above structure was afforded by two methods of synthesis. The first method of synthesis consisted of reacting equimolecular amounts of 2, 4, 5-triamino-6-hydroxy-pyrimidine, *p*-aminobenzoyl-1-(+)-glutamic acid, and 2-3-dibromopropionaldehyde in the presence of an acetic buffer.

The second method of synthesis was carried out by reacting 2, 3-dibromopropionaldehyde with pyridine and condensing the product with 2, 4, 5-triamino-6-hydroxy pyrimidine and potassium iodide and reacting the resulting product with *p*-aminobenzoyl-1-(+)-glutamic acid and sodium methoxide in ethylene glycol at 140°C.

In either method, the crude product contain-

ing about 15 per cent. of the biologically active material was purified by removing impurities precipitable by barium, extractable by butanol and adsorbed by charcoal and finally crystallizing the active material at pH 3.0. The name pteroylglutamic acid has been suggested for this compound.

This synthesis marks the culmination of active research work on different lines, viz., the elucidation of the chemical nature of the anti-pernicious anaemia factor of liver, the *L. Casei* factor and vitamin Bc, the anti-chick-anaemia factor, etc., and opens up a new chapter in the study of hæmopoietic substances. Although the synthetic folic acid has proved very effective in the treatment of macrocytic anaemias, it is interesting to note that the highly concentrated liver extracts of proved activity (15 U.S.P. units per c.c.), when tested microbiologically and on chicks, was found to contain hardly 1.0 µg. of free folic acid per c.c. even after treatment with vitamin Bc

conjugase.<sup>8</sup> Perhaps the antipernicious anaemia factor is a compound closely related to folic acid. Future research is expected to throw more light on this aspect and on the nature of the "intrinsic" and "extrinsic" factors.

G. B. R. SARMA.

\* R. B. Angier, J. H. Boothe, B. L. Hutchings, R. L. H. Mowat, J. Semb, E. L. R. Stokstad, Y. Subbarow, C. W. Waller, D. B. Cosulich, M. J. Fahrenbach, M. E. Hultquist, E. Kuh, E. H. Northey, D. R. Seeger, J. P. Sickels and J. M. Smith, Jr.

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## SLEEP AS AN ADAPTATION PHENOMENON

BY

INDERJIT SINGH AND MRS. SUNITA INDERJIT SINGH

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**EXPERIMENTS** on unstriated muscle have shown that activity is accompanied by concomitant inhibition, known as adaptation or accommodation, the extent of which varies. If this inhibition equals or exceeds the excitation process which produces it, then the tissue may be said to be in inhibition or asleep. Adaptation to this inhibition or adaptation<sup>1,2</sup> would result in awakening of the tissue, and the cycle would then be repeated.

Pavlov has described sleep as a kind of internal inhibition. Kleitman and others<sup>3</sup> confess some difficulty in understanding what constitutes the inhibitory impulse concerned in going to sleep naturally, where it arises and how inhibition is abolished previous to awakening. These difficulties can be explained as above if sleep is considered to be an adaptation phenomenon.

The depth of sleep may be measured in a number of ways.<sup>4</sup> It is found that there are wide individual variations, but often sleep increases in depth until two or three hours after the onset of sleep, it reaches its maximum. After this it decreases until six hours after the onset of sleep, and then stays approximately uniform. Just before the time to wake up is reached, it becomes very light. This curve of intensity of sleep is very similar to the curve of adaptation in unstriated muscle (Fig. 1).

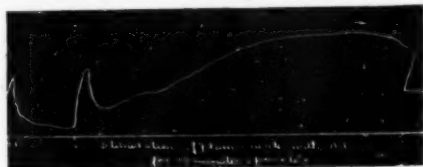


FIG. 1. *Mytilus* muscle. 1st contraction represents one following stimulation with alternating current (A. C.) 10 volts for 10 sec. The second with A.C., 10 volts for 10 minutes.

Just as the variations in sleep in individuals are many, so also the curve of adaptation in unstriated muscle to alternating current varies greatly in different muscles. This similarity suggests that sleep is an adaptation phenomenon, brought about by previous activity, and probably due to accumulation of calcium in some parts of the nervous system. The onset of sleep would then be due to adaptation and awakening, adaptation to adaptation. On this view, practically most of the phenomena connected with sleep can be explained.

**The sleep of the infant.**—The continuous sleep of the infant may be said to be due to rapidity of adaptation, and slow adaptation to this adaptation, as happens in some *Mytilus* and frog stomach muscles (Fig. 2). It appears that as age advances, this adaptation to the original stimulus becomes less; and adaptation to adaptation more rapid, as is found in some unstriated muscles.



FIG. 2. *Mytilus* muscle. Stimulation with A.C. for 10 minutes.

The problem of sleep has been approached<sup>5</sup> from the viewpoint that sleep is the basal state and wakefulness is a superimposed condition. This may be likened to an analogous state in some unstriated muscles, when the residual or threshold adaptation appears to be high, the factor causing adaptation appears to be increased in its free state, and more labile. With ageing these two factors diminish in intensity as happens with unstriated muscles which become more sensitive.

**Sleep of the adult.**—In sleep of the adult the adaptation to initial adaptation appears to be more rapid. As in adults or children, unstriated muscle may show one or two maxima (Fig. 3) wide variations are shown by adults as well as by unstriated muscle.

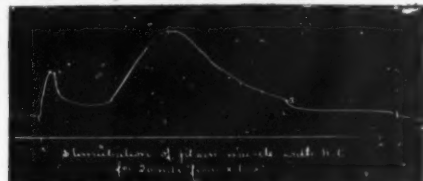


FIG. 3. *Mytilus* muscle. Stimulation with A.C. 10 volts for 20 minutes.

**Disturbances of sleep.**—Intractable insomnia will be due to lack of adaptation; in some unstriated muscles there is hardly any adaptation (Fig. 4). In others there is more adapta-

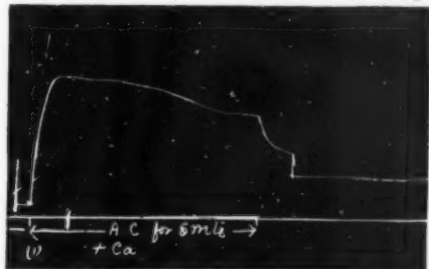


FIG. 4. *Mytilus* muscle. Stimulation with A.C. 10 volts for 5 minutes.

tion but incomplete (Fig. 5). Thus the muscle reproduces those phenomena which are similar

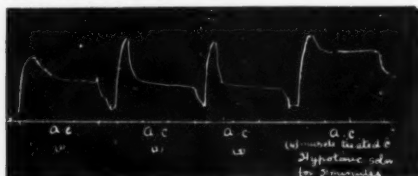


FIG. 5. *Mytilus* muscle. Stimulation with A.C. 10 volts for 3 minutes each.

to those of sleep of varying intensity. In some individuals sleep is disturbed often during the night; such a condition in muscle is shown in Fig. 6. This curve will also represent sleep

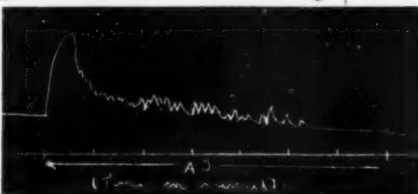


FIG. 6. *Mytilus* muscle. Stimulation with A.C. 10 volts.

with dreams. In some individuals sleep may be deep of short duration. This will be due to rapidity of adaptation to initial adaptation, as may be found in unstriated muscle.

**Evidence that sleep is due to adaptation.**—If sleep is due to adaptation, then it will be the result of activity. It is common knowledge that one desires to sleep if one is tired, in unstriated muscle, fatigue and adaptation are the same.<sup>6,7</sup> The great inclination to go to sleep as a result of excessive use of the eyes, the auditory apparatus or muscles is thus accounted for on this hypothesis.

The effect of activity is also shown by the following experiment. Three students did not sleep one night. The next day they could keep awake without much difficulty, but if they attended a lecture on nervous system, and paid attention to it, they fell asleep.

An interesting fact is that in unstriated muscle subliminal stimulation produces inhibition when greater stimulation excites the muscle;<sup>6</sup>

this is due to the fact that adaptation accompanying the excitation exceeds the latter, thus causing inhibition instead of contraction. The same appears to apply to sleep. Thus an infant may be put to sleep by rocking, patting or mild stroking of the back; travelling in a vehicle produces sleep. Lullabies act in a similar way. Even adults fall asleep in a running train; monotonous stimuli thus induce sleep; these stimuli if excessive will produce the opposite result. Procedures preparatory to routine sleep in one's life reduce excessive stimulation; thus it is found in unstriated muscle, that if the stimulation is excessive then inhibition or adaptation process is overcome (Fig. 7). Adaptation may not be equal in all

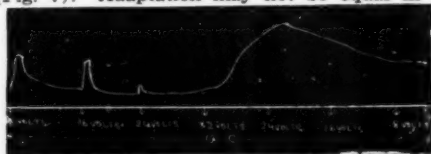


FIG. 7. *Mytilus* muscle. Stimulation with A.C.

parts of the cortex, thus accounting for sleep-walking, dreams, persistence of the sense of time during sleep, sensibility of the mother to the voice and movements of the child.

The injection of dilute calcium chloride into the third ventricle has been found by Demole to produce sleep. So it is possible that sleep is due to local accumulation or liberation of calcium in some part of the nervous system. There is a fall of the blood calcium in normal sleep and in that produced by sedatives and hypnotism.<sup>7</sup> This may be due to its withdrawal by the nervous system.

Adaptation may be effected by chemicals and from impulses from other parts of the brain, such as a "sleep centre". The effect of raw hen's eggs on one kind of insomnia<sup>8</sup> suggests that chemicals may effect this adaptation.

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### RADIO-ISOTOPES FROM ATOMIC PILES

THE cyclotron was a useful source of radio-isotopes and put at the disposal of research workers in medicine, biology and chemistry a supply of "tagged" or "labelled" atoms—atoms that can be traced and counted by convenient physical means. But in this field the cyclotron is now eclipsed by the atomic pile that was devised in connection with the atomic bomb programme. The uranium chain-reacting pile is far more efficient for synthesising these isotopes which for the first time are becoming available in really large quantities. Whereas a

millionth of a gram of a radio-isotope used to be something to talk about, radio-isotopes are now being prepared by means of the atomic pile in grams and, in some cases, kilograms. A month ago it was announced by the U.S. War Department that one hundred isotopes were coming into large-scale production and would be made available to hospitals, industrial and university research laboratories, and medical research institutions.

—(Discovery, August 1946, p. 227).



# A CASE OF PERSISTENCE OF THE LEFT SYSTEMIC ARCH IN A WEAVER BIRD, *PLOCEUS PHILIPPINUS PHILIPPINUS* (LINNÉ)\*

By BISWAMOY BISWAS, M.Sc.

(Research Scholar, Zoological Survey of India)

## INTRODUCTION

RECORDED cases of arterial abnormalities in birds are few. The majority of these abnormalities represent persistent embryonic vessels. Mackay (1888) recorded ligamentum botalli (arteriosum) and a ligamentous vestige of the left systemic arch in some species of birds. Hochstetter (1890) cited two cases of obliterated ductus arteriosus on one side in *Aquila naevia* and *Circus cineraceus*. Finn (1891) recorded the presence of right ductus caroticus (misnamed ductus botalli by him) in *Nycticorax violaceus* and *Dafila spinicauda*. Beddard (1898) mentioned the presence of a lumen in the vestige of the left systemic arch in *Spizæus* and *Aceros*. Bhaduri (1939) described the persistence of the right ductus caroticus in the pigeon *Columba livia intermedia*. Glenn (1939, 1940) recorded the presence of a functional left systemic arch in *Ceryle alcyon*. He also recorded the occurrence of the right ductus caroticus in *Zenaidura macroura carolinensis* (1940 a) and in *Dryobates v. villosus* (1943), and of the right ligamentum caroticum in *Loricopasser anoxantha* and *Loricopasser violacea affinis* (1942). He further described the presence of a short lumen in the distal part of the vestige of the left systemic arch while its anterior portion persisted as ligamentum aortæ in four species of Trogoniformes (1943 a). Recently two more cases of persistence of the right ductus caroticus in the pigeon are reported by Subhadrappa (1944) and Mathew (1944). Glenn (1940-45), and Bhaduri and Biswas (1945) have shown that the ligamentum botalli of the right or left or both sides are present in a large majority of adult birds.

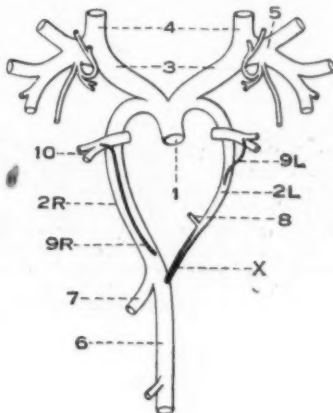
In the course of my studies on the cervical and thoracic arteries of birds I recently came across an interesting case of the persistence of the left systemic arch in a weaver bird, *Ploceus p. philippinus* (Linné). So far as I am aware no fully developed left systemic arch has been recorded from any adult avian species.

In this connection I should like to express my indebtedness to Dr. M. L. Roonwal, M.Sc., Ph.D. (Cantab.), F.N.I., Assistant Superintendent, Zoological Survey of India, and to Prof. J. L. Bhaduri, of the Zoology Department, Calcutta University, for some helpful suggestions in the preparation of this article.

## DESCRIPTION

The specimen was an adult female, and was, as far as could be seen, normal in all respects, except in the possession of a left systemic arch (Text-Fig. 1), which normally persists in a more or less obliterated condition in adult birds. The arterial system of the specimen was injected in the usual way.

The systemic arches (2) arise from a common root (1), and each sends the corresponding innominate artery (3), which as usual divides into the common carotid (4) and the



TEXT-FIG. 1. Main arteries in the region of the heart of the abnormal specimen of *Ploceus p. philippinus* (ventral view).

subclavian (5). The right systemic arch (2R) curves over the right bronchus towards the dorsal bodywall, whence it passes backward to form the dorsal aorta (6), which at once gives rise to the coeliac artery (1). The course of the left systemic arch (2L) is similar to the right one. It is, however, narrower than the right arch and gradually thins out into a solid strand (X) at the distal end where it joins the dorsal aorta. There is a lumen in the left systemic arch as is proved by the presence of the injection mass in it. The lumen gradually diminishes, becomes extremely fine, and is closed distally from where the arch is ligamentous. A small vessel (8) is seen to be given off from this arch near the distal end of the lumen. It is a very fine vessel and could be traced upto the pleura of the left lung.

A ligamentum botalli (9) is found on each side connecting the pulmonary (10) with the systemic arch.

## DISCUSSION

Ligamentous vestige of the distal part of the left systemic arches are common in birds, as shown by Mackay (1888),† Beddard (1898), Glenn (1940-45), and Bhaduri and Biswas (1945, and unpublished observations). Mackay

†He described the ligamentous vestige of the left systemic arch together with the left ligamentum botalli as ductus botalli.

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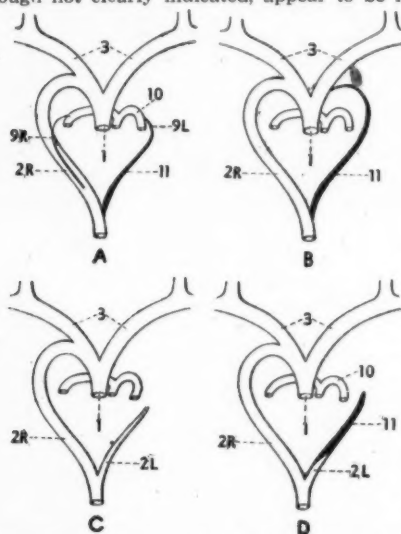
(1888) also described ligamentous vestige of the whole of the left systemic arch in some birds from his own as well as from Professor Macalister's observations.

Glenny's (1939, 1940) description of the persistent left systemic arch in the kingfisher *Ceryle alcyon* shows that its distal part is an open vessel, while its proximal part, i.e., the portion between the aortic root and the pulmonary arch is absent, and there is no ligamentum botalli. In *Temnotrogon reseigaster*, *Curucujus massena*, *Trogon melanocephalus* and *Trogon strigilatus*, according to Glenny (1943 a), the distal portion of the left aortic arch presents a short lumen while the anterior portion persists as a ligament. Beddard's (1898) instances of *Spizæus* and *Aceros*, though not clearly indicated, appear to be more

arch. This condition would indicate that obliteration of this arch in this specimen probably started from the distal end; but in the cases cited by Beddard and Glenny obliteration seems to have started from the proximal ends.

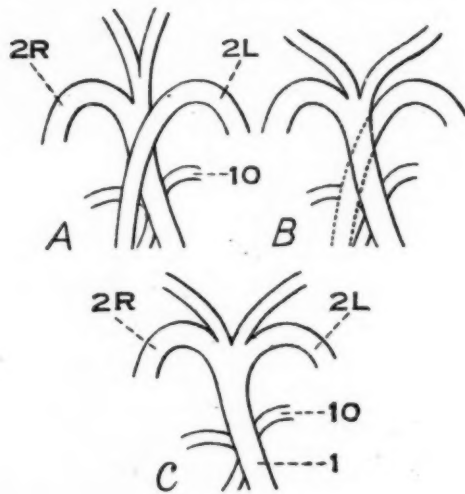
The general plan of the arterial arches in this specimen of *Ploceus* is very similar to that of middle and late embryonic periods in birds as figured by Glenny (1943 b). It approaches a reptilian condition—especially that of *Emys* (Hafferl, 1933), but in the present case there is no separate root for the left systemic arch. A probable explanation may be as follows.

It is well known that in the reptiles both the systemic arches have separate roots. If the fourth left (aortic) arch is obliterated we get the condition generally found in birds. From the disposition of the systemic arches in the specimen of *Ploceus* described above it appears that the root of the left systemic arch has disappeared earlier so that the original root of the right arch comes to serve for the origin of both the systemic arches (Text-Fig. 3).



TEXT-FIG. 2. Comparative diagrams of persistence of the left systemic arch in adult birds. A—Most prevalent type (after Glenny, and Bhaduri and Biswas); B—Condition in some *Raptores* and *Gulls* (after Mackay); C—Condition in *Ceryle* (after Glenny); D—Condition in *Spizæus*, *Aceros* and some *Trogoniformes* (after Beddard, and Glenny).

or less similar to those of the above species of *Trogoniformes*. A comparison of the recorded cases of the persistence of the left systemic



TEXT-FIG. 3. Schematic representation of the probable mode of transformation of the systemic arches from the reptilian to the condition observed in *Ploceus*. A—Condition in reptiles; B—Hypothetical intermediate stage; C—Condition in the present instance of *Ploceus*.

Key to the numberings in Text-Figs. 1-3

R = Right; L = Left.

1. Aortic root.
2. Systemic arch.
3. Innominate artery.
4. Common carotid artery.
5. Subclavian artery.
6. Dorsal aorta.
7. Coeliac arch.
8. A small vessel from the left systemic arch.
9. Ligamentum botalli.
10. Pulmonary artery.
11. Ligamentous vestige of the left systemic arch.
- X. Ligamentous distal end of the left systemic arch.

arch in adult birds (Text-Fig. 2) reveals that the case of *Ploceus* here presented is unique in that it is the distal and not the proximal end which is ligamentous in the left systemic

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Note.—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India.—Ed.

## WHALE MEAT FOR HUMAN CONSUMPTION

THE Department of Scientific and Industrial Research is sending a team to the Antarctic to make a scientific study of the possibilities of using lean whale meat for human food. The problems of selection, transport, storage and distribution of the meat will be investigated.

The scientists sail for the Antarctic this month in the whaling factory ship "Balaena". The expedition has been made possible by the collaboration of Messrs. United Whalers, who have generously provided a scientific laboratory and facilities for the investigation on board this new ship.

In the years before the war the world production of whale oil averaged about 500,000 tons a year, although there was considerable yearly fluctuation. In the production of this oil about 600,000 tons of lean whale meat was handled by the British and Norwegian whaling fleets. Some of this was de-hydrated and converted into animal feeding stuffs and fertilisers, but the rest was thrown back into the sea after the extraction of the oil. 600,000 tons of meat is something like half the pre-war import of meat into this country, but previous scientific enquiries have shown that only a proportion of this amount of whale meat can be suitable for human food.

The whale, besides providing an important supply of animal fat, in the form of whale oil, represents a potentially large supply of animal protein, which is untapped for food uses. A study of the possibilities and problems connected with the utilisation of whale meat is clearly of considerable practical importance at the present time. It is against this background that the Department of Scientific and Industrial Research has planned to send this expedition to the Antarctic. The results of the investigation will be followed with interest by the Ministry of Food, with whom the D.S.I.R. is co-operating closely.

This will be the second occasion that the D.S.I.R. has sent an expedition to the Antarctic. In 1939-40 the Department sent out a small team under the leadership of Lieut-Commander Marr, who has much previous experience of whales and whaling in connection with the investigations of the Discovery Committee. The results of that earlier expedition confirmed what whaling personnel have always claimed, that the meat of the whale is perfectly wholesome. Fresh whale meat can be very good to eat scarcely distinguishable from beef.

Like other meats, the quality and properties of whale-meat vary in different parts of the animal; they also vary according to age and sex and in the different types of whale (Blue, Fin, Humpback and Sei). The general

question as to how to make the best use of the lean meat of the whale can only be answered when more is known about the variability in the properties of the meat and about the basis upon which the meat could be selected for different food uses. There is no doubt that some proportion of the total would form a good and attractive meat if the problems of selection, transport, storage and distribution could be solved; and there is little doubt that types of whale meat which might be unsatisfactory for use as fresh meat, could be used for making highly nutritious and palatable processed foods.

The research team which is being sent out to the Antarctic this coming season will make a detailed study of the catch of the whaling factory ship "Balaena". Records will be kept of the size, species and various characteristics of the individual whales as they come aboard. The team will test the meat for palatability and carry out systematic studies in the laboratory on board in order to relate palatability to such characteristics as colour, acidity and nitrogenous extractives, which are the main constituents of meat extract, especially important for flavour. Separate records kept by an Inspector of the Ministry of Agriculture and Fisheries and by a biologist, who is being sent out by the Discovery Committee, will ensure complete documentation of the catch of this particular factory ship which may amount to perhaps 1,500 whales. It is hoped that the information obtained, in conjunction with the data collected by inspectors of other vessels, may make it possible to give a fairly accurate estimate of the characteristics of the lean meat of the present population of whales in the Antarctic.

The expedition will be led by Dr. R. A. M. Case, who has been lent to the Department of Scientific and Industrial Research by the Royal Navy Physiological Laboratory, where he has been studying the effects of high temperature, humidity and pressure on submarine crews. Dr. Case will naturally be interested in the general physiology of the whale and the bodily mechanisms which enable this curious mammal to lead a submarine existence. This subject is by no means unconnected with the qualities of whale meat as a food, because the character and composition of the muscles of the whales are adapted in several striking respects to the requirements of its under-water existence. There are indications from work carried out with material from earlier expeditions that, as an indirect consequence of this submarine adaptation, the proteins of whale meat are of exceptional value for growth in comparison with the meat proteins of land animals.

## LETTERS TO THE EDITOR

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### INTERFERENCE BY CERTAIN SUBSTANCES IN THE ESTIMATION OF THIAMINE BY THE THIOCHROME METHOD

THE chemical methods employed for the estimation of thiamine fall into two groups: (1) the colorimetric method and (2) the thiochrome method. A variety of substances have been shown to interfere in the colorimetric estimation of thiamine [Prebluda and McCollum (1939); Melnick and Field (1939); Emmet, Peacock and Brown (1940); Kirch and Bergeim (1942) and Sealock and Goodland (1944)]. A systematic study of this interference by certain substances in the colour development with diazotised *p*-aminoacetophenone has been recently carried out by Sealock and Goodland (*loc. cit.*). They found that the presence of heavy metal salts, potassium ferricyanide, hydroxyl amine, hydrogen sulphide, cysteine, iodine and sodium sulphite markedly influenced the reactivity of thiamine with the diazotised *p*-aminoacetophenone reagent, thereby giving low values for thiamine. Such a study, however, has not been carried out with the other chemical method, namely, the thiochrome method, employed for the estimation of thiamine. Thus, it was felt to be of interest to undertake this investigation, which was also of practical value, since the thiochrome method is being used in our laboratories for the routine assays of thiamine in foodstuffs and other biological materials.

The various substances under test were dissolved in water and such aliquots were added to the reaction mixture, so as to attain the final concentrations of the interfering substan-

ces ranging from  $10^{-2}M$  to  $10^{-5}M$ . The reaction mixture consisted of 10 ml. of the test solutions + 8 ml. of M/10 phosphate buffer pH 7.4 and 1 ml. of thiamine solution containing 100  $\mu g$ ; the final volume of the reaction mixture was adjusted to 20 ml. and it was incubated at 37°C. One aliquot was pipetted out as soon as thiamine was added to the reaction mixture and another after 90 minutes. The amount of the vitamin remaining in these two aliquots was estimated according to Bhagvat's (1943) method. A parallel incubation was carried out with 100  $\mu g$  thiamine + phosphate buffer pH 7.4. This served as a control. Following substances were tested:

(1) Mercuric chloride; (2) Silver nitrate; (3) Sodium tungstate; (4) Potassium ferricyanide; (5) Stannous chloride; (6) Ferric chloride; (7) Sodium nitrate; (8) Barium chloride; (9) Zinc sulphate; (10) Arsenious acid; (11) Iodine; (12) Sodium pyrophosphate; (13) Potassium oxalate; (14) Lead nitrate; (15) Sodium hydrosulphite; (16) Cysteine; (17) Potassium permanganate; (18) Sodium sulphite; (19) Hydrogen sulphide; (20) Glutathione; (21) Potassium iodide; (22) Sodium nitrite; (23) Calcium chloride; (24) Potassium perchlorate; (25) Barium nitrite; (26) Bromine; (27) Manganese dioxide; (28) Potassium iodate; (29) Formaldehyde; (30) Acetaldehyde; (31) Hydroxyl amine.

Out of 31 substances tested, only 9 were found to interfere with the thiochrome test. Low recovery of the added thiamine was obtained in the presence of these 9 substances, of which, mercuric chloride, silver nitrate, potassium permanganate, iodine and bromine, produced the greatest effect; hydroxyl amine, sodium sulphite, hydrogen sulphide and sodium



pyrophosphate were somewhat less effective in the concentrations used. Further, the interference encountered by these substances was found to increase on incubation. Substances such as sodium tungstate, potassium ferricyanide and cysteine, which were shown by Sealock and Goodland (*loc. cit.*) to affect markedly the thiamine values obtained by the colorimetric procedure, were found to be ineffective when the thiochrome method was employed for the assay of thiamine.

Next, an experiment was planned to find out if the interference encountered was a function of the relative concentrations of the interfering compound and thiamine. The results illustrated in Table I show that it was so.

TABLE I  
Percentage recovery of added thiamine at different concentrations of the interfering substances

Reaction mixture: 8 ml. M/10 Phosphate buffer (pH 7.4) + 1 ml. thiamine solution. (100  $\mu$ g) + 10 ml. solution of the interfering substance. Final volume 20 ml.

Substance	Final concentration of the substance	Percentage recovery of added thiamine	
		0 minute	90 minutes
Mercuric chloride	$5 \times 10^{-4}$ M	46.4	4.5
	$5 \times 10^{-5}$ M	82.2	12.5
	$1 \times 10^{-6}$ M	100.0	100.0
Silver nitrate	$5 \times 10^{-3}$ M	14.3	0.0
	$1 \times 10^{-3}$ M	27.3	0.0
	$5 \times 10^{-4}$ M	33.0	18.8
	$1 \times 10^{-4}$ M	36.0	36.0
Iodine	$1 \times 10^{-2}$ M	—	9.1
	$1 \times 10^{-3}$ M	6.7	7.1
	$1 \times 10^{-4}$ M	100.0	21.4
Sodium pyrophosphate	$1 \times 10^{-2}$ M	63.3	28.8
	$1 \times 10^{-3}$ M	100.0	100.0
Potassium permanganate	$1 \times 10^{-2}$ M	9.4	3.4
	$1 \times 10^{-3}$ M	70.4	4.5
	$1 \times 10^{-4}$ M	96.3	4.5
	$1 \times 10^{-5}$ M	100.0	100.0
Bromine	$1 \times 10^{-2}$ M	15.4	0.0
	$1 \times 10^{-3}$ M	68.2	0.0
	$1 \times 10^{-4}$ M	90.9	9.5
	$1 \times 10^{-5}$ M	90.9	16.7
	$1 \times 10^{-6}$ M	100.0	85.7

The influence of the pH of the reaction mixture on the extent of the interference exerted by the different substances was studied next. Thiamine solution was incubated in presence of the interfering substances at different pHs, (Acetate buffer was used to obtain pH from 4 to 5.6 and phosphate buffer to obtain pH 7.4) and the amount of thiamine left over was estimated (Table II).

TABLE II  
Effect of pH on the percentage recovery of added thiamine in presence of:  
Reaction mixture: 8 ml. of M/10 buffer + 1 ml. thiamine (100  $\mu$ g) + 10 ml. of solution of the interfering substance. Final volume 20 ml.

Substance	Concentration of the substance	pH	Percentage recovery of added thiamine	
			0 minute	90 minutes
Mercuric chloride	$1 \times 10^{-4}$	5	—	6.0
		5.6	—	6.4
		7.4	46.4	4.5
Silver nitrate	$1 \times 10^{-3}$	4	25.0	14.3
		5	25.0	14.3
		5.6	21.4	14.3
Iodine	$1 \times 10^{-3}$	7.4	27.3	0.0
		4.0	18.2	12.5
		5.0	18.2	8.3
		5.6	13.6	8.3
Potassium permanganate	$1 \times 10^{-3}$	7.4	6.7	7.1
		4.0	72.7	12.5
		5.0	81.7	8.3
		5.6	81.7	8.3
		7.4	88.2	0.0

The interference encountered in the presence of different substances tested above is not dependent on the pH of the reaction mixture.

The results presented in this paper and those reported by Sealock and Goodland (*loc. cit.*) definitely show the limitations of the two chemical methods used for the estimation of thiamine. The thiochrome method appears to yield better results than the colorimetric procedure, since fewer substances are found to interfere with the thiochrome reaction. The interference encountered with mercuric chloride and silver nitrate is probably due to the precipitation of thiamine by these compounds, that with iodine, due to the formation and precipitation of a resinous addition product and with potassium permanganate and bromine, due to oxidation of the thiamine molecule. The substances mentioned above are seldom encountered in thiamine-containing materials, but the possibility of similar difficulties being present could not be overlooked. Bhagvat and Devi (1944) have shown the presence of a thermostable factor in foodstuffs, which rapidly inactivated thiamine *in vitro*. This factor was found to retain part of its activity towards thiamine even on ashing.<sup>9</sup> Whether this was due to the presence in the ash, of substances of a similar nature as mentioned in this paper, is difficult to say. It is hoped that these results might prove of value in elucidating the nature of the antithiamine principle of foodstuffs.

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Coonoor,  
October 31, 1946.

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#### A MODIFICATION OF RAMON'S FLOCCULATION METHOD

RAMON (1922) by introducing the flocculation test, made the titration of Diphtheria Antitoxin a simple procedure. In this reaction the first tube to flocculate represents the tube where the antigen and antibody is just neutralized. It would have been the ideal method for assay of Diphtheria Toxin and Antitoxin, but as Glenn (1925) and other workers have pointed out, the results obtained by the *in vitro* method have not always agreed with the results obtained by the intracutaneous test method of Römer. The discrepancy may be due to the fact that in the *in vitro* method the first tube to flocculate may not be the tube where exactly the equivalent quantities of toxin and antitoxins are neutralized. In order to improve this test, we introduced certain agents which enhance the specific combination of toxin and antitoxin and also the flocculation reaction. After a great deal of search, it was found that a colloidal emulsion of Tolu Balsam which had been stabilized with cardiolipins served the purpose best.

In this modified method, small quantities of the above emulsion were added to the series of tubes containing the toxin and antitoxin. The toxin-antitoxin mixture which flocculated first in such series showed a neutralisation value which agreed well with that obtained by Römer's method. The size of floccules was definitely large and easy to detect, and in most cases the time of flocculation was hastened.

Detection of flocculation can further be facilitated by the addition of India ink.

Details of the experiments will be published soon.

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Bombay,  
October 18, 1946.

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#### BACTERIOLOGICAL GRADING OF INDIAN MILKS

MILK is particularly susceptible to microbial infection and spoilage during all stages of its production, processing, transport and distribution; the strictest bacteriological control is, therefore, essential at every step not only to prevent serious economic and nutritional losses due to its spoilage but also to safeguard the health of the people. Such controls, based on scientific methods of testing and grading milk,

are further helpful in preventing the inclusion of unsatisfactory supplies in bulked milk at collecting centres and providing information for price differentiation according to quality as a means of inducing the producers as well as distributors to maintain the highest standard of cleanliness in their methods of production. By a proper co-ordination of the various activities involved in the production and marketing of milk under centralised control and by an official enforcement of adequate standards of hygiene at all stages of milk handling, countries like England, Denmark and U.S.A., have succeeded in building up permanently a satisfactory milk supply for their people. The importance of introducing similar measures in India for improving and developing the national milk position is being increasingly realised. As a major step in this direction it is necessary to find out a simple, rapid and reliable method of testing milk and evolve suitable standards of quality for grading it. The most widely used methods in other countries for the purpose are the direct microscopic count, plate count, presumptive coliform test, methylene blue reduction test and resazurin test. Of these, the last one has recently come into great prominence as a very useful and discriminative method for assessing the hygienic quality of milk.

Both methylene blue and resazurin tests measure the rate at which reducing systems are produced by growing bacteria in milk. The latter is, however, more sensitive to the weak static reducing systems of leucocytes and other cells present in the milk at the actual time of the test and is thus responsive to high cell counts, which are frequently caused by mastitis.<sup>1,2,3,4</sup> The test is, therefore, of value in detecting abnormal milks (colostral, late lactation and mastitis milks) which are considered unsuitable for manufacturing cheese, butter and other milk products. The most important advantages of the resazurin test are, however, its rapidity and flexibility. The dye is reduced in two stages as a result of bacterial and cellular activity, first from resazurin (blue) to resorufin (pink) passing through various intermediate shades of purple, and then to dihydroresorufin (colourless). The first stage is irreversible and the second one reversible as in the case of methylene blue.<sup>3</sup> The test is carried out either by noting the colour change brought about after a definite period of incubation or by recording the time required for reduction to any particular colour shade or the final colourless form. Accordingly the results can be obtained in a much shorter time than in the case of methylene blue test and milks can be classified into two or more grades on the basis of the rates of resazurin reduction to different colour shades. A one-hour resazurin test<sup>1,2</sup> in which the milk is graded according to the colour change shown by resazurin at the end of one hour's incubation at 37°C. has been recommended for general milk testing and advisory purposes and some modifications of the same, suited for local conditions, have been adopted in England provisionally for official control purposes.

The introduction of the one-hour resazurin test for the routine testing and grading of milk

in India is expected to prove of great value in solving the national problem of organising and improving the milk supply position. Accordingly, the utility and applicability of this method for testing different kinds of milk marketed in India, viz., cow, buffalo and mixed milks, drawn from various sources reflecting the usual conditions of milk production and handling, have been critically examined at this laboratory. More than a thousand samples obtained in different seasons have been subjected to the one-hour resazurin test as well as plate count, methylene blue reduction test and occasionally microscopic examination.

For the resazurin test, one ml. of 0.005 per cent. resazurin solution (Eastman Kodak) was added to 10 ml. of milk in sterile test tubes, the tubes were tightly corked with sterile rubber bungs and incubated in a water-bath at  $37 \pm 0.5^\circ \text{C}$ . for one hour and the colour shade developed at the end of this period was observed.<sup>2,7</sup> The plate counts and methylene blue reduction times were determined simultaneously according to standard techniques.<sup>3,6</sup>

The results of the resazurin test have been compared with the corresponding plate counts and methylene blue reduction times in the following table. For the latter test a reduction time over 4 hours has been taken to indicate a satisfactory quality, which is found to be a suitable standard throughout the year for conditions prevailing particularly in Bangalore and generally in South India.<sup>8</sup>

TABLE I

Percentage distribution of one hour resazurin readings in different grades  
(Figures in the table indicate the percentage of samples in each resazurin class classified into different grades by the other two tests.)

One hour resazurin readings	Number of samples	Methylene blue reduction times (Hours)			Plate counts (per ml.)		
		Over 4	2 to 4	Below 2	Below 200,000	200,000 to 1 million	Over 1 million
Blue, lilac and mauve	527	70	30	..	47	46	7
Pink mauve	140	48	52	..	32	51	17
Purple pink	108	39	47	14	34	40	26
Pink	69	3	38	59	..	25	75
Colourless	161	..	2	98	..	2	98

A reasonably good agreement is found between the two reduction tests. Some discrepancies which are indicated, are due to (a) the greater sensitiveness of resazurin test to the action of leucocytes present in some of the samples (as revealed by microscopic examination) and (b) the closer relation which resazurin reduction has with the initial reducing substances formed in milk.<sup>4</sup> Both these factors are in favour of resazurin test. There is only a general relationship with plate count but all high count samples are detected by the test.<sup>4,9</sup>

On the basis of the above results, the following standards for grading Indian milks according to the one hour resazurin reduction stage appear to be satisfactory.

## One hour resazurin reduction

- |                              |         |
|------------------------------|---------|
| 1. Blue, lilac and mauve     | Good    |
| 2. Pink mauve or purple pink | Average |
| 3. Pink                      | Poor    |
| 4. Colourless                | Bad     |

## Grade proposed

These standards are more or less in agreement with those suggested by foreign workers except in the case of the intermediate grades to a slight extent.<sup>2,3</sup>

A standard comparator disc showing the different resazurin colour shades, prepared in England with reference to Shorthorn cow's milk (4 per cent. fat), is put on the market by Messrs. Tintometers, Ltd., London. As this is not found to give satisfactory results for Indian milks (particularly buffalo milks) suitable colour standards for the purpose are being prepared. In the meantime it is hoped that the test will be tried out in other laboratories in this country under different climatic and environmental conditions so that comparative data may be obtained for standardising the test with a view to its official recognition and adoption for the grading of Indian milks.

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October 2, 1946.

H. LAXMINARAYANA.

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## VITAMIN REQUIREMENTS OF SOME LACTIC MICRO-ORGANISMS

In a previous communication, the vitamin requirements of some lactic micro-organisms from the National Collection of Type Cultures, India, Indian Institute of Science, Bangalore, were reported. This is a supplement to the previous one. The vitamin requirements of two more of the lactic micro-organisms L.C. 12, N.C.T.C. 2087 and L.C. 9, N.C.T.C. 2084 have now been studied. The experimental details of preparing the media, inocula and the handling of cultures were the same as those described previously; in the present series of studies, however, 2 ml. of the media in small tubes

TABLE I  
ML. of 0.1 N acid produced per 10 ml. of basal medium

Culture	All Vitamin	No vit.	-B <sub>1</sub>	-B <sub>2</sub>	Pantothenic acid	-B <sub>6</sub>	-Niacin	-Biotin	-Pab	Folic acid
L.C. 9 N.C.T.C. 2084	16.0	3.18	15.48	5.2	4.7	15.8	6.50	8.50	15.1	15.8
L.C. 12 N.C.T.C. 2087	16.2	2.11	13.4	4.11	3.94	8.1	2.79	6.71	16.01	16.0

(4 ml. capacity) and a 4 per cent. concentration of sugar were employed. The acid produced after 72-hour incubation at 37° C. was titrated against 0.05 N alkali delivered from a microburette. The results given below are expressed as ml. of 0.1 N acid produced per 10 ml. of basal medium.

The results indicate that the cultures under study do not require thiamine, *p*-aminobenzoic acid and folic acid. L.C. 9 does not require pyridoxin in addition. L.C. 12 shows great promise of lending itself to niacin assays. The non-essentiality of folic acid for these organisms is a gratifying circumstance since it offers the possibility of assaying amino-acids with media without employing the difficultly available folic acid.

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Section of Fermentation Technology,  
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Bangalore,  
October 8, 1946.

1. Mistry, S. P., and Sreenivasaya, M., *J. Sci. Ind. Res.*, 1945, 4, 162. 2. —, Gajjar, I. M., and Sreenivasaya, M., *Curr. Sci.*, 1945, 14, 95.

#### CHEMICAL COMPONENTS OF THE FLOWERS OF *MORINGA PTERYGOSPERMA*

THE medicinal virtues of the several parts of the plant *Moringa pterygosperma* Gaertn. (N.O. Moringaceae) have long been known and appreciated in India.<sup>1</sup> The bark was examined by Ghosh, *et al.*<sup>2</sup> and two bases were isolated, the total amounting to 0.1 per cent. One of them which was obtained in the form of the crystalline hydrochloride had only feeble pharmacological activity. The other, designated moringinine, was a light brown liquid having a strong action like that of the sympathomimetic bases.<sup>3</sup> It failed to give crystalline salts.

The flowers are considered to possess stimulant and aphrodisiac properties and are used as a tonic, diuretic and cholagogue. They have now been examined chemically with a view to isolate any crystalline components that may be present. The air-dried material gave a figure of 4.8 per cent. for moisture and 11.0 per cent. for ash which was rich in potassium and calcium. The fresh flowers have a mild

characteristic smell but from the stem distillate no essential oil could be isolated even by resorting to extraction with petroleum ether. Extraction of the dry material with different solvents in succession gave the following results: (1) Petroleum ether extract 5.3 per cent.; (2) ether extract 0.7 per cent.; (3) chloroform extract 0.8 per cent.; and (4) alcohol extract 11.6 per cent. The first consisted mainly of wax and oil. Cold acetone removed most of the oil and from the residue, by repeated crystallisation from absolute alcohol, a wax having the following properties was obtained: m.p. 69-72°; acid value 10.5; saponification value 29.8; unsaponifiable matter 75.5 per cent. The ether extract (2) was a greenish wax solid and seemed to consist mainly of carotenoid pigments. The chloroform and alcohol extracts (3) and (4) contained some basic substances which gave positive tests with some of the alkaloidal reagents. The alcohol extract contained in addition much resin and some mineral matter. A final water extract was rich in reducing sugars and in potassium and calcium salts.

For the isolation of the basic constituents the air-dried flowers were directly extracted with boiling alcohol. The syrupy residue obtained by the concentration of the extract *in vacuo* was poured with stirring into a large volume of 1 per cent. aqueous hydrochloric acid. The clear aqueous solution containing the salts of the bases was freed from non-basic substances by extraction with chloroform, then rendered alkaline with ammonia and repeatedly extracted with chloroform. The combined chloroform solution was washed with water, dried over potassium carbonate and distilled. The dark brown amorphous residue gave the following reactions with alkaloid reagents.

#### Colour Tests

Mecke's reagent (Selenious acid in sulphuric acid)—Reddish brown.

Mandelin's reagent (Ammonium vanadate in sulphuric acid)—Brown with violet tinge. Other common reagents—Negative.

#### Precipitation Tests

Mayer's reagent—White.

Picric acid—Yellow.

Potassium bismuth iodide—Orange.

Iodine in potassium iodide—Scarlet.

Auric chloride—Pale yellow (small rectangular plates).

The yield of the bases was so poor that it was not possible to obtain any crystalline salts with the amount of substance available. The



possibilities of getting larger quantities of the flowers for investigation in the immediate future are remote in view of the difficulty of collection. Since Ghosh *et al.* (loc. cit.) have not described the colour reactions of the basic substances isolated by them it is difficult to compare with properties of the bases of the flowers with those of the bark.

The above results indicate that the medicinal properties of moringa flowers are to be ascribed partly to the basic constituents present in traces and partly to the inorganic salts (potassium and calcium) present in fair amounts. Since the essential oil is present only in insignificant amounts the dried flowers should be almost as useful as the fresh ones.

The authors' grateful thanks are due to Prof. T. R. Seshadri for his kind interest in this work.

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S. SANKARASUBRAMANIAN.

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Waltair,  
October 10, 1946.

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# ON THE COMPOSITIONS OF CUPRIC AMMINO CHLORIDES

In continuation to our previous work<sup>1</sup> on cuprammonium compounds, I have studied the compositions of the cupric aminochlorides by the electrical conductivity method. The experimental procedure was the same as described in our previous publications.

The composition-percentage difference in conductivity graph gave breaks corresponding to three, four, five and six molecules of ammonia for a molecule of cupric chloride. These results confirm the existence of the well-known hexa-, penta- and tetra-ammino compounds of cupric chloride. I do not get the evidence for the existence for  $3\text{CuCl}_2 \cdot 10\text{NH}_3$ , but instead I get a break in the curve corresponding to the composition of the compound,  $\text{CuCl}_2 \cdot 3\text{NH}_3$ . It appears that the previous workers isolated a mixture of the tri-ammino compound with the higher compounds and hence this anomaly in the result.

Detailed results will be published elsewhere.

I thank Dr. A. K. Bhattacharya, Head of the Chemistry Department, University of Saugor, for his kind interest in this work.

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May 20, 1946.

ARUN K. DEY.

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# THE OCCURRENCE OF THE LAKI SERIES IN JODHPUR STATE

Of the Tertiary rocks in Jodhpur State nothing more is known than what is contained in "The Geology of Western Rajputana" (*Memoirs Geo-*

*logical Survey of India*, Vol. 35, Pt. 1, 1902), by Tom D. La Touche.

"The upper limit of the sandstones (Barmer sandstone)", he wrote, "is concealed by the alluvium of the plain, and nothing can be seen of the overlying beds. A fine unctuous clay or fuller's earth, which may overlie the sandstones, is found at Kapurdi, a village about twelve miles to the north of Barmer, and is quarried for sale as "Multani Mitti". It may be of lower Tertiary age, for the same substance is found and quarried to the north-east in Jaisalmer and Bikaner territory and is there associated with numulitic limestone" (pp. 33-34).

A reconnaissance survey of the western part of the State was recently made. Unfortunately, however, in the rocks exposed in the area extending from Barmer to Gunga in a north and south direction and from Akli to Bhiyar in an east and west direction no outcrops of the numulitic limestones could be detected. The outcropping rocks comprised sandstones, various clays and ferruginous shales but did not reveal the presence of any fossils.

A search was then made in the Kapurdi (Long.  $71^\circ 22' 30''$ :  $25^\circ 54' 30''$ ) fuller's earth bed for any fossil remains and the following were detected:—*Nuculana* (*Sacella*) sp.; *Tibia* sp.; *Trachycardium* sp.; *Corbula* sp.; of microforaminifera, *Ammobaculites* and *Cibicides* sp. An indeterminate echinoid and an indeterminate gastropod were also detected.

Both the fossils, *Nuculana*, and *Cibicides* belong to forms which have so far been found only in the Laki.

In a recently excavated well at Nagurda (Long.  $71^\circ 24' 20''$ :  $26^\circ 9' 15''$ ) about twenty miles north of Kapurdi some more fossils were collected.

The section exposed in the well is as follows:—Lime kanker 0-8 ft.; Loose sand with quartz pebbles 8-21 ft.; Fuller's earth 21-36 ft.; Mud-stone 36-42 ft.; White fireclay 42-70 ft.; Yellow soft sandstone 70-83 ft.; Loose yellow sands 83-90 ft.; Spongy ferruginous sandy shale 98-108 ft.

The fossils collected here contained *Lucina metableata*, *Corbula* sp., *Nucleana* sp.; *Venericardia* sp., *Pitar* sp. Of microparaminifera, *Ammobaculites*, *Bathysiphon*, *Cibicides*, *Globigerina* sp., *Lagena* sp., *Rotalia* sp., *Trochammina* sp. nov., and *Turritina* were identified. The forms of *Cibicides* and *Turritina* detected here have so far been found only in the Laki. Of Ostracoda, three different forms of *Cythereis* were identified. All the above came from the fuller's earth bed. The only fossil detected in the fireclay bed above, was *Discors* sp.

Most of the fossils belong to species which do not carry published names, but were identified with the help of specimens in the Burma Oil Company's collection.

My grateful thanks are due to Messrs. P. Evans, J. Coates and F. E. Eames, of the Burma Oil Co., Ltd., for invaluable help in the determination of the fossils.

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### NITROGENOUS FERTILIZERS IN RELATION TO THE KEEPING QUALITY OF POTATOES

RUSSELL AND GARNER (1941),\* studying the effect of manuring on the keeping quality of potatoes stored in the outdoor pits, found that about 7 per cent. by weight of the potatoes went bad on storage; dung in the bouts increased this loss to nearly 9 per cent. Sulphate of ammonia had but little effect; superphosphate and potash did not decrease the loss but if anything, increased it. This note deals with the effect of storage on the rotting of potatoes, variety: Darjeeling Red Rose, grown at the College Farm during 1943-44 and fertilised with ammonium sulphate at 80 lbs. N per acre, applied before planting. Tubers from control and manured plots were each divided into big and small groups, those weighing above 45 gms. per tuber being classed as big. They were then stored separately in wooden trays between sand layers from March 15, 1944 to September 13, 1944. The rotted tubers were removed at definite intervals and the mean temperature of the storage room recorded for these periods.

#### Percentage of Rotting in Tubers Harvested from Manured and Unmanured Plots

Period of storage from March 15, 1944 (Days)	Mean temp. during storage (°C.)	Size of tubers	Per cent. rotting in tubers harvested from	
			Unmanured plot	Manured plot
20	22.5	Small	0.14	0.24
		Big	nil	nil
40	26.9	Small	0.99	1.45
		Big	2.15	2.60
80	32.0	Small	1.70	2.97
		Big	6.45	7.79
90	33.8	Small	6.38	16.62
		Big	19.35	40.26
120	31.2	Small	18.66	34.49
		Big	36.55	58.44
150	27.7	Small	21.27	36.56
		Big	40.86	64.93
180	27.7	Small	23.50	37.50
		Big	45.21	66.20

It may be observed from the results (Table) that (1) as commonly observed, the small tubers had a better keeping quality than the big tubers; and (2) ammonium sulphate application increases rotting on storage.

The high percentage of rotting that usually occurs in storage at normal temperatures might thus be due to nitrogenous fertilizers which are frequently applied to the potato crop. However, as high yield of potato tubers depends also on adequate supply of nitrogenous fertilizers, it is advocated that a small unmanured plot may be planted with potatoes, its produce alone being retained for storage and subsequently, for seed.

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October 1, 1946.

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\* Russell, E. J., and Garner, H. V., *Emp. J. Expt. Agr.*, 1941, 9, 227-35.

### ON THE LEPTOCEPHALUS OF URO- CONGER LEPTURUS (RICHARDSON) FROM THE MADRAS PLANKTON\*

DIFFERENT types of Leptocephali occur in the Madras Plankton, and of these, two of the common varieties have been correlated with their adults (namely, *Muraenesox cinereus* and *Muraena macrura*) by allowing them to metamorphose into the adult eels in the Laboratory aquarium tanks (Nair, 1946). Owing to the difficulty of obtaining these larvae in the living condition from the townet collections, this conclusive method of identification is not always possible and as such the usual method of correlation by myotome and vertebral count has to be employed for identifying the other species.

The Leptocephalus of *Uroconger lepturus* appears in considerable numbers in the Madras Plankton generally during the months of January to April.

#### Measurements

Total length 112 mm.; length of head 6 mm.; length of trunk 76 mm.; length from anus to tip of tail 30 mm.; length from tip of snout to origin of dorsal fin 43 mm.; maximum height including dorsal fin 11 mm.

The Leptocephalus is transparent with a highly flattened body having 216 myotomes approximately. The posterior portion of the body gradually tapers into a finely pointed tail (Fig. 1) and in this respect the larva resem-



FIG. 1. Leptocephalus of *Uroconger lepturus*.  $\times \frac{1}{2}$

bles *Leptocephalus acuticaudatus* described by Kaup (1856) from Malabar. The head is roughly triangular in shape with large eyes and a blunt snout (Fig. 2). The jaws are of nearly

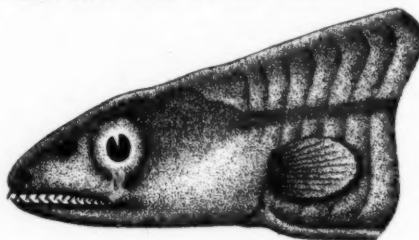


FIG. 2. Head region of the Leptocephalus of *U. Lepturus*.  $\times 6.5$ .

the same length and carry forwardly directed pointed teeth. The upper jaw has about 22 teeth of which the anterior 8 are stronger and longer than the remaining ones. The lower jaw has about 14 teeth. The cleft of the mouth is straight and extends to about half the length of the head. The alimentary canal is very long and takes a straight course with the anus opening to the outside below the 116th

myotome. Indications of the rays are present in the pectoral fin.

A group of black chromatophores is present below the eye and this pigmentation is a characteristic feature of the larva. A series of large black chromatophores is present arranged in a line along the lateral line and the chromatophores are situated on the myocommas with regularity. Occasionally a myocomma may be present without a chromatophore. A similar series of black chromatophores is found along the ventral margin directly above the alimentary canal. The pigment cells of this series are smaller, numerous and closely arranged than those of the mid-lateral series. These chromatophores are elongate excepting some of the anterior ones. The anteriormost and the posteriormost region of the body are generally without any pigment cells.

In the majority of examples collected the larval set of teeth has dropped out and indications of the adult set are seen as minute conical projections. Further, in these specimens, the length of the alimentary canal is considerably reduced with the anus occupying a very anterior position. These changes evidently show that metamorphosis has commenced in these larvae.

*Uroconger lepturus* is a common eel of the Madras Coast and Alizarin preparation of a medium-sized specimen showed 218 vertebrae. The vertebral number of the adult is approximately similar to the myotome number of the larva and this similarity shows clearly that the *Leptocephalus* is that of *Uroconger lepturus*. Further evidence in support of this correlation is given by the fact that this is the only species of larval and adult eel with a tapering and whip-like tail occurring along the Madras Coast.

I am thankful to Dr. N. Kesava Panikkar for his helpful suggestions.

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September 20, 1946.

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\* Work carried out under a scheme of research financed by the Imperial Council of Agricultural Research, New Delhi.

#### A NATURAL FUNGUS PARASITE OF POWDERY MILDEW ON CYAMOPSIS PSORALIODES DC.

AN interesting case of a fungus parasitizing another fungus came to light recently in Bangalore. During September-October this year, there was a profuse development of powdery mildew, *Leveillula taurica* (Lév.) Arn., on the cultivated cluster bean or *gori kayi* (*Cyamopsis psoraloides* DC.). On the mildew patches, greyish points were prominent, and these on examination proved to be groups of pycnidia of the parasitic fungus, *Cicinnobolus cesatii* De Bary. This is an imperfect fungus belonging to the group of the

Sphaeropsidales. The pycnidia are light-brown in colour, and oval in shape, with a thin pseudo-parenchymatous wall. They extrude numerous small hyaline, oval or oblong spores. The measurements of the pycnidia and spores agree fairly closely with those recorded by Sydow and Butler. The pycnidia measure from 52-72  $\mu$  long by 36-50  $\mu$  broad, average being 59.9  $\mu$   $\times$  42.4  $\mu$  (against 45-104  $\mu$   $\times$  39-60  $\mu$ , mostly about 60  $\times$  40-45  $\mu$ ), and the spores 7.9  $\mu$  long by 3.4  $\mu$  broad, average being 7.6  $\mu$   $\times$  3.65  $\mu$  (against 5.8  $\mu$   $\times$  2.5-3.5  $\mu$ ). *Cicinnobolus cesatii* has been recorded on the oidial stages of many powdery mildews, and is sometimes known to aid in checking them. The extent of control cannot apparently be very great, as the mildew thrives in spite of the parasite, and brings about, under favourable conditions, a large amount of leaf-fall. Nevertheless the existence of the parasite is most probably a check to the full development and spread of the mildew.

The fungus, *Cicinnobolus*, was first observed by Cesati in the province of Tuscany in Italy in the year 1852, and was described by Tulasne from France in 1853. De Bary, about the year 1870, proved the parasitism of the fungus on the powdery mildew, *Oidium Tuckeri*, and *O. erysiphoides*, occurring on the leaves of the grapevine and other plants. *Cicinnobolus cesatii* has been noticed all over the world, and particularly in Italy, France, Portugal, Holland, Great Britain, Egypt, Canada and United States of America, on the mildews of various plants, Sydow and Butler\* described it for India from a collection made by Butler at Pusa in October 1910 on *Oidium* sp., occurring on *Phaseolus mungo* var. *radiatus*. There is no other mention of this fungus in India. Hence this record of its occurrence on *Leveillula taurica* (Lév.) Arn. is new to India.

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October 9, 1946.

\* Sydow, H., and P., and Butler, "Fungi Indiae orientalis," *Pars. V. Annales Mycologici*, 1916, 14, 190. See also Butler, E. J. and Bisby, G. R., "The Fungi of India," *Sci. Mono.* 1, *Imp. Coun. Agr. Res.*, 1931, 182.

#### A PRELIMINARY NOTE ON A NEW KARYOTYPE IN SCILLA INDICA BAKER

RAGHAVAN AND VENKATASUBBAN (1939) in their studies on the Indian *Scilla*, have described three distinct karyotypes in *Scilla indica* Baker, with the diploid chromosome number as 44, 45 and 46.

The plant under investigation was collected on the Kolar hills in Mysore State, and has been found to represent another distinct karyotype revealing a diploid chromosome number of 30; this number has not so far been reported in the species.

*Scilla indica* Baker, collected by us is a small bulbous plant flowering in May. The root-tips were forced in water culture, fixed in Levitsky's chromic-formalin and stained with crystal violet (after La Cour). Fig. 1

shows the thirty chromosomes in the somatic metaphase plate. There are two pairs of very



FIG. 1. Somatic metaphase plate  $\times 4050$ .

large chromosomes and the size of the chromosomes suddenly diminishes, consisting of six pairs of medium-sized and seven pairs of small

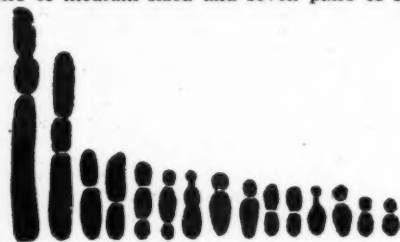


FIG. 2. Idiogram of the somatic haploid complement  $\times 4050$ .

chromosomes. The constrictions are mostly submedian and subterminal.

Further work on the meiotic chromosomes and the other aspects is in progress.

The authors wish to express their grateful thanks to Dr. K. V. Srinath for helpful criticisms, and Dr. L. N. Rao for kind encouragement.

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October 24, 1946.

I. Raghavan, T. S., and Venkatasubban, K. R.,  
*Cytologia*, 1939, 10, No. 1-2, Pp. 189-204. 2. Darling-  
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*of Chromosomes*, 1942, London.

#### USE OF COAGULATED PLAIN SERUM FOR MAINTENANCE OF CORNY- BACTERIUM *DIPHThERIAE*

DUDLEY (1923) recommended plain serum instead of Loeffler's medium containing glucose broth for maintenance of toxin-producing strains of *C. Diphtheriae*. Recently Forbes et al. (1945) tried coagulated plain serum (C.P.S.)

in an outbreak of Diphtheria and found it much superior to Loeffler's medium for isolation of *C. Diphtheriae* from throat swabs.

In this laboratory, stock cultures of toxin-producing strains of *C. Diphtheriae* (P.W. 8) were maintained on Loeffler's medium and on C.P.S. side by side to find out whether repeated subcultures on C.P.S. affect the toxigenicity of the strain.

**Preparation of the Medium.**—The C.P.S. was prepared with serum from normal horse blood. The fresh serum, sterilized by seitz filtration, was inspissated at 75°C. for 45 minutes for one day only.

**Comparison of the C.P.S. and Loeffler's Serum Media.**—Pellicles from 18 hours growth of *C. Diphtheriae* in dextrose broth were seeded into Loeffler's and C.P.S. tubes. The results obtained after 12 consecutive subcultures at intervals of 14 days are summarised in Table I.

TABLE I

Strain used	Medium used		
	C.P.S.	C.P.S. + 0.25 p.c. Glucose	C.P.S. + 0.25 p.c. glucose + $\frac{1}{8}$ vol. nutrient broth
Park William 8	+++ =	+++	++++

(+ indicates intensity of growth)

On C.P.S. and C.P.S. with 0.25 per cent. glucose (Table I) the time taken for maximum growth was longer (48 hours) than on Loeffler's medium (24 hours). On first few subcultures, the growth was scanty but after 4 or 5 subcultures, the growth was satisfactory, though not as good as with Loeffler's medium.

Morphological character of the organisms did not alter after repeated cultures on C.P.S. or on C.P.S. with 0.25 per cent. glucose.

For maintenance of stock culture, subcultures were done every 14 days on the different media. For production of toxin, fresh cultures were made on the respective media. After 24 hours incubation, they were charged into dextrose broth tubes and finally into broth flasks to obtain toxin. The average potency of toxins (Lf. doses per c.c.) are recorded in Table II.

TABLE II

(Figures indicate Lf. doses per c.c. of toxin—average of 12 experiments)

Strain used	C.P.S.	Medium used for maintenance of stock cultures	
		C.P.S. + 0.25 p.c. glucose	C.P.S. + 0.25 p.c. glucose + $\frac{1}{8}$ vol. nutrient broth
Park William 8	28	28	28

#### DISCUSSION AND CONCLUSION

It appears (Table I) that on C.P.S. growth of the toxin-producing strains of *C. Diphtheriae* (P.W. 8) is not as good as on Loeffler's medium.



Probably glucose and broth supply additional nutrient as growth promoter. The toxigenicity of the organism was not affected on repeated subculture on C.P.S. over a period of six months. The C.P.S. medium is very simple. For laboratory diagnosis of diphtheria, where detection and isolation of the organism is of primary importance, the C.P.S. has been observed to have advantage over Loeffler's medium. But for maintenance of stock strain for routine production of toxin, it is yet too early to recommend its use in preference to Loeffler's medium though results obtained so far are encouraging. Further work in the line is in progress.

Our thanks are due to Dr. P. N. Basu, M.B., for his interest and guidance in the work.

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## A RICE DIET FOR THE PRODUCTION OF EXPERIMENTAL FATTY LIVERS

THE deposition of fat in the liver has become a subject of major interest in biochemistry since it was shown that dietary factors play a dominant role in liver-fat deposition and that conditions predisposing to fatty livers in short-term experiments cause liver cirrhosis in more prolonged experiments.<sup>1,2,3,4,5,6</sup> Excessive amounts of fat<sup>7</sup> or carbohydrate<sup>8</sup> in the absence of a sufficiency of choline,<sup>9</sup> methionine<sup>10</sup> or protein<sup>11</sup> are the chief dietary factors that have been shown to be responsible for the production of fatty livers. For the purpose of investigating dietary factors involved in the aetiology of infantile cirrhosis of the liver, which is widely prevalent in S. India, and for studying the lipotropic activity of proteins and protein hydrolysates, it became necessary to devise a carbohydrate-rich experimental diet based upon rice and with rice as the sole source of protein, which would cause fat infiltration into the liver. It was found that fatty livers could be easily produced experimentally in rats by the use of a diet approximating in protein and carbohydrate content to the S. Indian vegetarian diet. The results of experiments on groups of animals maintained on diets of the following composition (Table I) are described here.

TABLE I  
Per cent. Composition of Diets

	Rice Flour	Rice Protein	Casein	Coconut Oil	Sucrose	Salt Mixture*
Diet I (Protein, 20%)	58	0	16	15	7	4
Diet II (Protein, 5%)	58	1	0	15	22	4
Diet III (Protein, 5%)	58	1	0	25	12	4

\* Steenbeck-Nelson Salts (4).

All these food mixtures had as their basis 58 per cent. raw rice flour, supplying approximately 4 g. of protein. Diet I for the control animals, contained in addition 16 per cent. casein. In Diets II and III the protein content was brought to 5 per cent. by addition of about 1 per cent. of pure rice protein, prepared by the method of Tadokoro.<sup>12</sup> The exact quantity of rice protein to be added was determined by an estimation of the protein content of rice flour, which was usually 6.9 per cent. ( $N \times 6.25$ ). Diets I and II contained 15 per cent. fat (refined coconut oil) and Diet III 25 per cent. fat. Each rat received in addition 1 drop cod liver oil and the following supplements of vitamins of the B complex, per day: 25 micrograms thiamin hydrochloride; 20 micrograms riboflavin; and 20 micrograms pyridoxin.

Young albino rats, approximately 70 g. initial weight, were placed in groups of 6, animals of the two sexes being distributed evenly between the groups. The food was provided ad lib. and the daily intakes recorded. Weighing of animals was done twice a week. After 35 days on the diets the animals were killed by stunning. The livers were immediately removed and individually worked up for the determination of total crude fatty acids (fatty acids+unsaponifiable matter) according to the method used by McHenry and Gavin.<sup>13</sup>

The results are summarized in Table II.

TABLE II  
Groups of six rats maintained for a period of 35 days

Diet	Av. food intake (g./day)	Av. Final body wt. (g.)	Av. change in body wt. (g.)	Liver		
				Av. fresh wt. (g.)	% Body wt.	Crude fatty acids (% fresh liver wt.)
I	8.0	107	+30.5	3.52	3.45	4.47 ± 0.22
II	6.0	90	+11.0	4.49	5.00	9.06 ± 1.43
III	5.5	72.5	+4.1	3.63	5.03	8.84 ± 0.99

It will be seen that in the animals on the low protein diets the fat-content of the liver

is about twice that of the normal animals on a balanced diet. There is no significant difference in the liver-fat deposition in the groups receiving 15 and 25 per cent. fat. These results were always found to be reproducible. The weight curves of the animals (Fig. 1) are in-

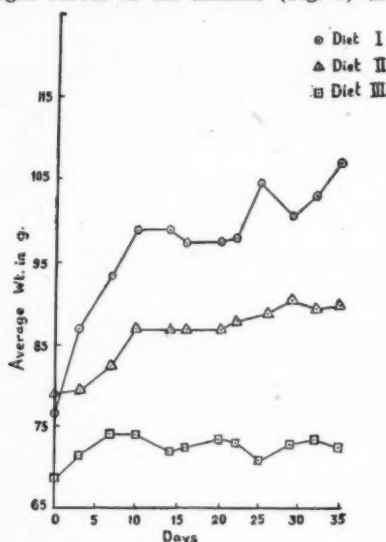


FIG. 1. Weight Curves

structive. Curve I is the usual growth-curve of rats receiving a complete diet. Curve II,

representing the animals on a low protein diet with 15 per cent. fat, shows a slow but steady increase in weight; while with Diet III, containing 25 per cent. fat, it is obvious that the imbalance is so great that the animals show hardly any growth. For this reason Diet II is recommended as the most suitable for the study of lipotropic factors, as it has been pointed out by other authors (cf. Handler<sup>14</sup>) that characteristic fatty livers in young rats are not produced when dietary factors present do not permit at least slow growth.

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Madras,  
September 17, 1946.

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## ASTROPHYSICS AND V-2 ROCKETS

THE military program of V-2 Rocket firing at White Sands, N.M., is enabling astronomers to use "extremely expensive apparatus for the exploration of the upper air, and for making preliminary observations outside the major portion of the atmosphere," according to Dr. J. Allen Hynek, of Perkin's Observatory.

The rocket to be fired on October 24th will be equipped by the Johns Hopkins group, carrying principally apparatus for recording the intensities of cosmic rays and for photographing the far ultra-violet spectrum of the sun. At the Astronomers' meeting, Dr. Hynek described the spectrograph designed for the solar observation; its successful operation would for the first time release astronomers from the limitation of earth-bound instruments. They have yet to observe extra terrestrial radiation of wave-lengths shorter than about 3,000 Angstroms because it is absorbed by the ozone and other layers in the rarefied upper air.

As ordinary glass also absorbs ultra-violet, the prisms and lenses of the spectrograph are of lithium fluoride with which it is hoped to reach 1,500 Angstroms or better. The film-recording mechanism consists of a ten-sided rotating steel rod, eight sides of which have

affixed to them strips of film. The entire plate holder is encased in a light-tight steel cylinder which preliminary drop tests have shown to be exceedingly rugged. Clockwork controls the exposures, turning successive faces of the polygon into the focal plane as the flight progresses.

It is evident, however, that aiming the spectrograph so that the sun will shine exactly into the slit will be practically impossible. A small hemisphere of lithium chloride placed over the slit will act as a diffuser to pick up sunlight even if the apparatus is not pointed directly to the sun. The V-2 is known to rotate slowly about its longitudinal axis, and the hope is that at least some of the exposures will be taken in a favourable aspect.

Uncertainty in the intensity of the radiation, in the transparency of the sky, and in the orientation of the slit make exact exposure prediction difficult, so a step-slit will be employed, making the exposure at one end considerably shorter than at the other. The dispersion will be 50 Angstroms per millimetre.

—(Courtesy of Sky and Telescope, October 1946, p. 7.)

## REVIEWS

**Forest Soils and Forest Growth.** By S. A. Wilde. (The Chronica Botanica Co., Waltham, Mass.; Macmillan and Co., Ltd., Calcutta), 1946. Pp. i-xx + 1-241; 7 plates and 24 figures. Price \$5.00.

Many books have been written by foresters about the forest plant community as a vegetative complex and many books have been written by soil scientists regarding the soil as an intimate biological whole. This book, however, is one of the few which regards the soil and the forest growing on it as one great harmonious complex.

Until quite recent years soil scientists have in general neglected serious considerations of the vegetation that grows or can grow on the soils they were examining and foresters often have paid all too little attention to the soil that supported their forest. In the very early pages the author aptly quotes a forester who described the situation that existed not so long ago:—

"How well I remember the many hours of careful measurement we used to make to determine the volume of a stand and then kick our heel into the ground, grab a fist-full of soil and litter and determine the soil that made this growth possible in the twinkling of an eye."

The book originated from a series of lectures prepared for a rather heterogeneous group of students including graduates and advanced students in soils, forestry, botany, game management, and landscape architecture and hence its broad and somewhat unconventional treatment of the subject.

The author begins with a historical introduction showing how the studies of soils and forests started separately and how gradually they necessarily came together. He then deals with how soils came into being and how they have been classified. He continues with a description of the forest vegetational cover of the soil and shows its biological structure and relation to environment. This is followed by detailed descriptions of forest soils separately for the aspects of their physical properties, chemical properties, their living population of organisms both large and small, and the humus which is the forest's great organic contribution to the soil in the form of dead and decaying vegetation.

Having thus covered the soil, the forest, and their interdependence, forest soil types are described and details are given of forest soil surveys and how they are carried out.

Following this is a series of chapters dealing with the effect of the soils on the forests and the effect of different kinds of forest management on the soils. One of the big problems dealt with is the amelioration or improvement of forest soils by the use of fertilisers, manures and composts. This is often necessitated by the fact that in general only the poorest soils are legitimately used for forests while the better soils are usually reserved for agricul-

ture. In addition, it often happens, that in order to use these poor soils set aside for forests, the type of forestry is determined by the needs of the local people or local industries. These uses may necessitate methods of forest management which are often not the best for maintaining and improving the fertility of the soil and hence some form of amelioration or modification of forest management becomes essential. Nowhere is this felt more heavily than in permanent forest nurseries where year after year crops of young tree plants are grown on the same site. A typical example of this is in the great shelter belt scheme of the U.S.A., in which in the last ten years they have raised many thousands of miles of tree shelter belts to try and fix the shifting and wind-blown soils of the great "dust bowl". This necessitated the raising of many millions of forest trees in nurseries near the planting sites on soils not usually suitable for the purpose. Only the greatest care in maintaining the fertility of the soils of these nurseries enabled the project to be carried through successfully.

The book is well printed and is very readable although it is definitely not popular in style but of the text-book variety. It is well illustrated by a number of text-figures. One criticism, however, must be made. At the end we find a number of plates each of which contains half a dozen or more photographs. They are excellent photographs which well illustrate the points they are intended to cover and it appears a pity that more was not made of them. They are jammed up on the pages and tend to lose their effect by their smallness. A book of this kind deserves better illustration production. It concludes with a comprehensive bibliography of over 600 references.

This publication will be greatly welcomed by foresters and soil scientists alike for it is real and practical and not academic only in its outlook as are so many books on forestry and on soils. It truly presents the soil and the forest growing on it as a teeming living harmonious complex and not just a mixture of mud and wood.

A. L. GRIFFITH.

**Vitamins and Hormones, Vol. III.** Edited by Robert S. Harris and Kenneth V. Thimann. (Academic Press Inc., New York), 1945. Pp. xv + 420. Price \$6.50.

The third volume of this internationally recognised and eagerly welcomed series of publications needs no introduction. It includes nine articles, each of them representing an authoritative and critically appraised review. The interrelation of vitamins in its functional, unbalanced dosing, toxic and synergic aspects, is discussed by Moore; in the author's own words, "any attempt to co-ordinate, rather than to collect together, the examples of interrelation so far reported might at the present stage only make confusion worse confused. If we

accept the evidence now available at its face value, however, we must infer that interplay between vitamins is extensive and complicated. The various roles of riboflavin may be taken as affording a good illustration of the complexity of the problem: (1) We are told that this vitamin reacts with ascorbic acid *in vitro* under the influence of light; (2) it is present in the retina where it possibly interacts with vitamin A in the formation of visual purple, and on separate evidence is concerned with vitamin A and ascorbic acid in dark adaptation; (3) it is associated with thiamine and niacinamide in oxidative mechanisms for carbohydrates; (4) possibly it takes part with niacinamide in protein metabolism; (5) there is a suggestion that it has some correlation with synthesis or metabolism of ascorbic acid; (6) finally it is said to prevent the injurious effect of marine fatty acids, which are in turn antagonistic towards vitamin E. Such a "diversity of interests" may be claimed for several other vitamins, which leads, at least on paper, to a complicated network in which almost any two factors which have not been proved to interact directly may be assumed to influence each other through their relations with a third factor."

The second review in the volume on the Bacterial Synthesis of B Vitamins in the Intestine, is one of the great theoretical interest and practical significance in human nutrition. Can man and beast attain a state of self-sufficiency, complete or partial, with respect to the B-complex? If so, what is the extent and the manner through which it is accomplished? An up-to-date answer to these questions is furnished by this article. Of even greater importance and significance to animal and human nutrition is the fourth article on Prenatal Nutrition Deficiencies. The author has focussed attention of interested investigators in this field on problems which await solution; says the author, "The appearance of the mother does not always betray her nutritional state and in case of deficiency the foetus may suffer more than the mother. It has been shown in animal experiments that a vitamin A level sufficient for maternal health may result in disaster to the offspring; and vitamin A-deficiency does not affect the teeth of the mother so severely as those of the young. A mother with latent beriberi may give birth to a child with congenital manifestations of the disease. Female rats with a riboflavin deficiency so mild that they can undergo repeated pregnancies, often give birth to young who have the most severe malformations. Female animals fed on iron-deficient diets without developing anaemia produce iron-deficient offspring that develop anaemia. These examples will suffice to illustrate that in the struggle for nutritional factors between mother and offspring it is not always the foetus who obtains what he needs. The finding of critical periods in the development of the embryo, in which there is unusual susceptibility to nutritional deficiency, opens new perspectives in the field of prenatal nutrition. It emphasizes the importance of a satisfactory nutritional state of the mother in the earliest periods of pregnancy."

The fifth review is devoted to a comprehen-

sive and critical discussion of the growth-factors in microbiology and covers more than a fourth of the volume (125 pages). This is a field in which biochemists, medical bacteriologists and fermentation technologists are all interested. The seventh contribution relates to a discussion of the chemistry of the anti-pernicious anaemia substances of liver; it is written by one who has made substantial contributions to the field. The article is an admirable review of a difficult and controversial field and gives a clear picture of the present status of the subject. Other articles in the volume include (1) Sulphonamides and Vitamin Deficiencies, (2) Possibilities in the Realm of Synthetic Estrogens, (3) The Mechanism of Action and Metabolism of Gonadotropic Hormones in the Organism and (4) The Role of Acetyl Choline in the Mechanism of the Organism. On the whole the volume has fulfilled the high expectations of the wide circle of scientific investigators interested in vitamins and hormones, not only in the matter of the choice of the topics but also in the choice of the reviewers. We share with the Editors the hope that "the subject-matter of successive volumes will integrate more and more until *Vitamins and Hormones* eventually becomes a complete reference to all active research in the vitamin and hormone field."

#### Annual Review of Physiology, Vol. VIII.

By James Murray Luck and Victor E. Hall.  
(American Physiological Society and Annual Reviews Inc., Stanford University P.O., California), 1946. Pp. viii+658. Price \$5.00.

The eighth issue of the *Annual Review of Physiology* contains twenty-five reviews. Prefacing the volume, the Editors restate their declared Editorial policy in the preparation of these reviews. "Encouragement is given only to the preparation of reviews which survey the important contributions of the preceding year or biennium, which appraise them critically and evaluate with discrimination the present status of the subject. Comprehensive reviews in which the task of the author is one of compilation rather than of appraisal are deliberately eschewed". The Editors have felt convinced that the special function of the review should lie in criticism and appraisal; this policy is largely reflected in the reviews.

War-time restrictions on the publication of the results of physiological research, more especially in its applied aspects, however, continue although to a less severe degree. When the ban is lifted, may we expect a flooding of the pages of these *Annual Reviews* with an account of the spectacular achievements made under the stimulus of war.

The topics discussed in the volume cover, in addition to the familiar subjects, a few fresh aspects of physiology; Blood Cytology and Aviation Physiology represent two such topics. The volume is generously documented (3,598 references to literature) thoughtfully indexed and attractively got-up. These reviews will continue to have ever expanding circulation and constitute an indispensable part of all progressive libraries interested in the advancement of physiological research in its fundamental and applied aspects.



**The Genus *Bazzania* in Central and South America.** By Margaret Fulford. (Waltham, Mass.: Chronica Botanica, Ltd.; Calcutta: The Macmillan & Co.), 1946. Pp. 175. Price \$5.00.

Taxonomic hepaticologists of the 19th century based their studies on herbarium specimens alone. This has led to an unnecessary multiplication of species and found a climax in the monographs of Stephani. Dr. Kashyap and Dr. Verdoorn were greatly impressed by the range of variability shown by Hepaticae, when studied in the field and felt the necessity of critical revision of literature of a close examination of the herbarium material. Dr. Verdoorn has given this idea a practical shape by arranging to publish such monographs.

This excellent monograph by a hepaticologist of long standing is the fifth of the series arranged by Dr. Verdoorn (1-4 already published as supplement, Vols. I-IV of *Ann. Bry.*). The author's name is well known to all interested in Bryology. This monograph incorporates suggestions from Dr. Evans—the nestor of American hepaticologists. The author has critically examined herbarium materials of 100 species and varieties of genus *Bazzania*. One of them has been transferred to another genus and as many as 71 have been reduced to synonymy. This should bring home to all taxonomists that they should be very careful in describing new species. It is an excellent model and like other monographs of the series published already is bound to be of immense use to all interested in the subject.

R. S. C.

**Biochemical and Allied Research in India, Vol. 15.** (Society of Biological Chemists, Bangalore, India), 1944. Pp. 87. Price Rs. 3 or 6 sh.

The Society of Biological Chemists of India has been responsible for issuing these extremely useful and informative Reviews during the last fifteen years; they have been instrumental in focussing attention on the highlights of scientific achievements in the field of Biochemical Research in this country. That the Society has been able to continue these annual publications even during the difficult years of the World War and to maintain a reasonably high standard in the presentation of these reviews, is a matter on which the Society may well feel proud.

These reviews can play a more useful and a more purposeful part if the Editors of the Review could infuse new blood into the reviews. Reviews of the work done in India may with advantage be critically appraised and comparatively presented against an international background of work in similar and allied fields. India is backward in many fields of scientific endeavour; the reviewer might in all appropriateness, point out the *lacunae* existing in our research organisations and plead for the inauguration of new lines of and fresh approaches to research and emphasise the urgent need for an immediate modernisation of our techniques and laboratories.

We have no doubt that these suggestions will receive the earnest consideration of the Editorial Committee. We shall in the coming

years look forward to an even more useful and inspiring series of Reviews.

**Recent Advances in the Chemistry and Biology of Sea-Water.** By H. W. Harvey. (The University Press, Cambridge), 1945. Pp. viii + 164. Price 10sh. 6d. net.

The study of the marine environment is one of considerable interest to scientific investigators of the flora and the fauna which enrich the life of the sea. The physical and chemical factors which determine the overall 'quality' of the environmental complex, are influenced by a variety of natural causes. The geographical location of the sea, the proximity of lands and estuaries, the presence of oceanic warm springs and streams, the ridges and the ravines of the sea floor, the turbulent flows due to tidal waves and volcanic eruptions, are some of the physical factors which influence the environment. The salinity, chlorinity, concentration of the major and the minor constituents, the phosphatic and the other nitrogenous compounds, the dissolved oxygen and the carbon dioxide, are some of the factors which directly affect the chemical and the nutritional status of the environment.

Dr. Harvey's volume under review is an authoritative contribution to this field of the marine environment in relation to its plant and animal life. In the course of the ten interesting chapters which comprise the volume, the author has summarised in a clear and concise manner the large volume of work which has been carried out in this field. The introductory chapter is devoted to a discussion of mixing and the horizontal transport of sea-water which tend to maintain a certain degree of uniformity of conditions in the sea. The second chapter deals with the salinity, chlorinity and the specific gravity of sea-water. Methods for their determination are described and the interrelationships of these factors discussed. The third and the fourth chapters describe respectively the major and the minor constituents of the sea. The minor constituents include the organic carbon compounds and the salts containing nitrogen and phosphorus. The fifth chapter deals with dissolved oxygen, its occurrence and distribution at different depths and during different seasons. The carbon dioxide system of sea-water is described in the sixth chapter.

The distribution and estimation of phosphates and of nitrogen-containing salts forms the topic of the seventh chapter; colorimetric and biological methods of estimating phosphates and various forms of nitrogen are described and the significance of the nitrogen/phosphorus ratio discussed. The next chapter is devoted to a discussion of the changes induced by bacterial action; this is followed by a description of the phosphorus and the nitrogen cycles (Chapter IX). The tenth and the last chapter is concerned with the fertility of the ocean waters as determined by the abundance of planktonic harvests, which meet the nutritional requirements of the higher forms of life in which the sea abounds. This is a volume which will be enthusiastically welcomed by every one interested in the fundamental and practical aspects of marine biology.

## OXIDATION\*

THE discussions organised by the Faraday Society serve to prove the advantage of considering scientific knowledge as international. Attracted by a bond of common interest, experts from far and wide collect together for an unrestricted exchange of ideas about a scientific theory capable of wide applications in its different aspects. Knowledge advances and the world benefits. The general discussion on oxidation held in London was quite up to the reputed traditions of the Faraday Society discussions. These were held at the University College, London, under the Presidentship of Professor E. K. Rideal, F.R.S., and were attended by a number of scientists from the U.S.A. and Europe.

The subject of oxidation is as wide in its scope as it is varied in its aspects. A large number of papers were contributed and were considered under the following:—

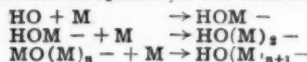
- (1) Oxidation processes involving electron transfers.
- (2) Low temperature oxidation of hydrocarbons.
- (3) Oxidation at high temperature in the gas phase.

In most oxidation processes in aqueous media, the first step consists of a simple electron transfer. This, however, is followed by subsequent reactions involving fundamental rearrangements within the molecule. In the present discussions, the electron transfers, the nature of the loose electrons, the ions and radicals formed as a consequence of electron transfers and the reaction chains set up by free radicals, are the main ideas which have been applied to understand the mechanism of secondary reactions in oxidation-reduction processes. The theory of chain reactions as applied to thermal reactions laid the foundations of many of the fundamental ideas. Study of thermal reactions no doubt supplied the tools but their application in a new orientation has opened up a vast field whose extent and fruitfulness has been fully brought out during these discussions.

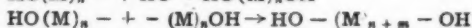
In systems of conjugated double bonds, Weiss approaches oxidation through an electron transfer resulting in the formation of an unstable intermediary ion. Weiss also considers the quenching of fluorescence of polycyclic hydrocarbons by molecular oxygen as an electron transfer process:  $RH^* + O_2 \rightarrow [RH]^+ + O_2^-$ , a more or less stable peroxide being formed. He extends the same idea to cases of photosensitised oxidation where an  $HO\cdot$  radical can be formed, which in the presence of a suitable acceptor easily brings about an oxidation. Electronic transfers in oxidation processes, however, often involve complicated rearrangement of bonds within the molecules. In the first paper Coulson has given his method of calculations of bond order, on which depends the reactivity of a bond. Though in matters of detail and the extent of mobility of the

$\pi$  electrons, calculations may have to be revised, the treatment lends a quantitative theoretical basis for the degree of bond fixation and ultimately to reactivity of molecules concerned.

The idea of a chain of mechanism initiated by a free radical has been applied to polymerisation processes of vinyl compounds. Hydrogen peroxide, potassium persulphate and other inorganic substances are known catalysts for polymerisation processes. It has been found that traces of various substances greatly accelerate the rate of polymerisation. With  $H_2O_2$ , the rate is markedly accelerated by the presence of ferrous, manganous, cuprous, titanous and other metallic ions. In a series of papers Bacon, Baxendale and co-workers, and Morgan have studied the polymerisation of monomers like methylacrylate, methylacrylic acid, styrene, etc. Polymerisation by  $H_2O_2$  is greatly accelerated by ferrous ions. A new polymerisation technique called "reduction activation" which is most effective in aqueous solutions has been worked out by Bacon. The presence of reducing substances capable of reacting with the oxidising agent, accelerates the polymerisation of ethylenic monomers. The increased activities are explainable through the formation of intermediary free radicals or radical ions and thus form evidence for the same. In the case of  $H_2O_2$  and ferrous ions, there is satisfactory evidence for the formation of  $OH$  radical. The reaction is accelerated by a chain mechanism, the hydroxyl radical attacking the double bond of the monomer and producing other free radicals which react with further molecules of the monomeric compound in the following manner:



The chain is terminated by mutual reactions between growing chains or by  $OH$  radicals thus:

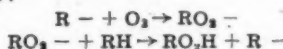


Kinetics have supported the general scheme. Other cases of polymerisation are also considered to occur through a transient intermediary. The exact nature of the radical or the intermediary catalyst as in the case of the persulphate reaction are not always definitely known and many assumptions have often to enter into these considerations. Study of kinetics of these reactions affords a powerful instrument to probe into the life and formation of the radicals and rapid developments in this sphere can easily be expected.

The next series of papers deal with low temperature oxidation of hydrocarbons. It has been generally established that hydroperoxides are formed as a first step in the oxidation, and the oxidation products and the mechanisms by which the reactions proceed are, however, not clearly understood. The nature of the oxidation products are generally very complicated and kinetic treatment in many cases is precluded owing to lack of knowledge of experimental conditions suitable for the study of chain sequence. There is a considerable difference of opinion on secondary reactions and on the chain terminating processes.

\* A short review of the general discussion held under the auspices of the Faraday Society at the University College, London, on 27th and 28th Sept. 1945, under the Presidentship of Prof. E. K. Rideal, F.R.S.

The first set of papers deal with oxidation of tetralin. This substance is suitable for the study of oxidation of  $\text{CH}_2$  group because of its high oxidation rate and the ease with which it yields an easily separable crystalline solid hydroperoxide in the primary oxidation process. The autoxidation of tetralin, without catalysts, shows an induction period. In the early stages about 95 per cent. of the absorbed oxygen is estimable as the hydroperoxide. The hydroperoxide itself can function as a catalyst and by its breakdown furnishes free radicals which can generate the chain mechanism. In heavy metal catalysed oxidation of tetralin, the primary reaction is the chain formation of the hydroperoxide, followed by catalysed unimolecular decomposition of the catalyst. In a general way the participation of free radicals is amply justified. It is generally considered that the hydrocarbon  $\text{RH}$ , gives rise to radicals  $\text{R}^\cdot$ , which react in the sequence:



The reactions for the termination of the chain are not always definite. Surface effect and reactions with the peroxide or the catalyst have been suggested for the process.

The thermal decomposition of benzoyl peroxide is monomolecular and produces benzoate and phenyl radicals which initiate chains. George and Robertson have studied the kinetics and have found a monomolecular order for the catalysed oxidation of tetralin and by analogy suggest a chain mechanism similar to the benzoyl peroxide reaction. A bimolecular rate has also been found for some of the peroxide catalysed oxidation. In the absence of sufficient kinetic data heats of reaction values have been utilised to formulate probable reaction mechanism. The oxidation of the olefins, ethyl linoleate, ethyl linolenate and methyl oleate, have been shown to follow a chain mechanism. Bolland and Gee consider that the oxidation of ethyl linoleate is accompanied by a double bond displacement. It is suggested that one of the chain carriers is the free radical  $\text{R}_2\text{CH} = \text{CH}\cdot\text{CH} = \text{CH}\cdot\text{R}'$ , which has other

forms of resonance configurations and forms isomeric peroxide radical with  $\text{O}_2$ . Though the chain mechanism is considered to be the same, squalene behaves differently from the other olefins inasmuch as the peroxide yield which is smaller at the earlier stages of reaction appears to be unrelated to the extent of oxidation. It is evident that further data are necessary for a fuller understanding of the detailed mechanism. The oxidation of rubber, hydrocarbon fuel, coal, etc., have been considered. The points of oxygen attack, the nature of the peroxide, structural influences on the reaction and scission products are the main topics of discussion. Peroxide formation has been established and a similar mechanism has been suggested. In the oxidation of carbon, a complex containing active oxygen has been postulated and the process is suggested to be similar to organic peroxide formation. In the absence of complete data, however, most of the conclusions have to be tentative.

Oxidation of the hydrocarbon in the gas phase forms the subject of discussion in the third section. The chemical products, the kinetics and the reaction chains and mechanism in oxidation processes, during detonation, explosion and slow combustion producing cool flames, have been considered under this section. Spectroscopic methods for detection and analysis of the products of the reaction have been applied. Knock in an internal combustion engine is caused by a high velocity explosion wave. An active oxidation catalyst, probably a peroxide capable of setting up reaction chains, is considered to be generated, but the exact nature and method of production of the knock-producing entities are not very definite. Prettre and Perrin are of the opinion that the production of carbon monoxide and hydrogen by the catalytic oxidation of methane is not a direct reaction. They used a catalyst containing 12 per cent. nickel and found that the exit gases always contained  $\text{CH}_4$ ,  $\text{CO}$ , and  $\text{H}_2\text{O}$ . They concluded that the initial oxidation of methane produces  $\text{CO}$ , and  $\text{H}_2\text{O}$ , which through further endothermic reactions with the residual methane, give  $\text{CO}$  and  $\text{H}_2$ . Topps and Townend have investigated the light emission during ignition of mixture of oxygen with ether and acetaldehyde. A technique has been described for the spectroscopic analysis of the luminescence. Depending on experimental conditions, a cool flame, produced at lower temperature and a more intense blue flame are observed. The spectrum of the cool flame is identical with the fluorescent bands of formaldehyde excited under radiations. The exact mechanism of the process is not clear as chemical analysis does not give detectable quantities of formaldehyde. The measured temperature of cool flames is not sufficient for a purely thermal excitation of formaldehyde molecules. Calculation from intensity measurements with acetylide gave a very low efficiency for the emission process. It has been suggested that methyl alcohol, whose oxidation under certain conditions gives an identical spectrum, might be a factor in the production of cool flame of acetaldehyde, but experimental data are not sufficient for a definite conclusion.

Short-lived radicals and free atoms play an important part in combustion reactions. Oxygen atoms and  $\text{NO}$  react to give a continuous emission spectra with its maximum in the yellow-green and thus afford a method for the detection of oxygen atoms in flames. The presence of oxygen atoms has been utilised in various chain mechanisms put forward to explain combustion reactions. An example is afforded in the oxidation of  $\text{SO}_2$  in combustion flames studied by Dooley and Wittingham.  $\text{SO}_2$  is formed in flames by the oxidation of  $\text{SO}$ . A technique for the direct determination of  $\text{SO}_2$  is described. Dew points were determined by an electrical conductivity method by streaming the gaseous mixture across a cooled glass vessel in which two thermocouples were fixed and by measuring the increase in conductivity consequent on the deposition of the  $\text{H}_2\text{SO}_4$  mist. The reaction is explained by the intermediate formation of  $\text{H}_2\text{S}$ ,  $\text{CS}$ , and other sulphur compounds which generate  $\text{CS}$  and  $\text{CO}$  radicals. These radicals by chain reactions

evolve oxygen atoms which ultimately produce  $\text{SO}_2$  by interaction with  $\text{SO}_2$ .

Combustion reactions in fuel beds have been investigated by Thring. Deep fuel beds are favoured in technical practice to avoid mechanical lifting of particles. Considerable amounts of  $\text{CO}$  are consequently produced by the reduction of  $\text{CO}_2$  and excess air has to be fed in to burn the  $\text{CO}$ . Complete combustion without much excess air and a  $\text{CO}_2$  content approximating 20 per cent. in the combustion gases from coke, are the ideal conditions for maximum temperature in a furnace. An experimental furnace is described in which the air stream is directed downwards on the surface of the fuel bed, by means of a nozzle

of variable aperture. By the down jet combustion method, the  $\text{CO}_2$  content of the issuing gases is raised and a higher furnace temperature is attained. The various factors connected with this new technique in furnace design are discussed. The oxidation of yellow phosphorus and the photochemical oxidation of formaldehyde are dealt with in the last two papers. The glow accompanying the slow oxidation of phosphorus is a cold flame. Hydrocarbons act as poisons by using up the atomic oxygen required for the chain propagation. The photochemical reaction between oxygen and formaldehyde at temperatures below those of the thermal reaction has been investigated.

P. B. G.

## SCIENCE NOTES AND NEWS

### IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH

A MEETING of the Governing Body of the Imperial Council of Agricultural Research was held in New Delhi on the 25th and 26th September 1946. The Hon'ble Dr. Rajendra Prasad, Member for Food and Agriculture, was in the Chair. Among those who attended were Provincial Ministers of Agriculture—Mr. M. P. Patil from Bombay, Mr. N. A. Sherwani from the U.P., Sardar Swaran Singh from the Punjab, Dr. Syed Mahmud from Bihar, Sri Nityananda Kanungo from Orissa and Dr. Rameshwar Agnibhoj from the C.P.

Ten schemes of national importance on agriculture and twelve on animal husbandry were sanctioned. It was also decided that the name of the Imperial Council of Agricultural Research should be altered to Indian Council of Agricultural Research. The procedure for shortening the period of 19 months taken at present for sanctioning schemes to 7 months was also approved. The Governing Body also approved the scheme for bringing out Urdu and Hindi editions of the Council's popular Journal *Indian Farming*.

#### Agricultural Schemes

- (1) Tests with D.D.T., 666 and allied insecticides, at the I.V.R.I., Madras, Bombay, U.P. and the Punjab.
- (2) Co-operative experiments on fungicidal sprays.
- (3) Insect pests of paddy.
- (4) Contribution to the Indian Botanical Society.
- (5a) Improvement of pastures (Punjab).
- (b) Improvement of pastures (Bengal).
- (6) Manurial experiments on paddy lands.
- (7) Nitrogen fixation in soils.
- (8) Rice research scheme.
- (9) Physiology of pulses.
- (10) Medicinal plants.

#### Animal Husbandry Schemes

- (1) Effect of humid climate on cattle.
- (2) Standardisation of ration for ryots' cattle.
- (3) Bacteriological standards for market milk.
- (4) Dairy technology.
- (5) Sheep (Damani) breeding.
- (6) Rapid and detailed determination of fat, etc., of milk.
- (7) Helminth parasites of poultry.
- (8) Sheep and goat disease.
- (9) Research on the biology of marine prawns.
- (10) Laboratory for wool analysis.
- (11) Disease Investigation Officer scheme.
- (12) Linoleic acid content of ghee.

The Twelfth Annual Meeting of the Indian Academy of Sciences is scheduled to be held at Allahabad from the 26th to 28th December 1946 jointly with the National Academy of Sciences, Allahabad.

**Fuel Research Institute, Digwadih.**—The Hon'ble Mr. C. H. Bhaba, Member for Works, Mines and Power in the Interim Government, laid the Foundation Stone of the Fuel Research Institute at Digwadih, Dhanbad, on Sunday, the 17th November 1946. Sir S. S. Bhatnagar, Director of Scientific and Industrial Research, welcomed the guests and Dr. J. W. Whitaker, Director of the Institute, extended the vote of thanks.

#### ERRATA

Volume 15, No. 8, August 1946, page 234, lines 16-18 (Note entitled "Chromosome Numbers in Bambuseae"): For "it is found that mostly all of them come under  $n = 35$  and  $2n = 70$ , while Riccharia groups with the basic number  $n = 12$ ", read "it is found that mostly all of them come under either  $2n = 48$  or  $2n = 72$  chromosome groups with the basic number  $n = 12$ ".



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